The Lower North Shore Transportation Improvement Study

A report produced by the

Central Transportation

Planning Staff for the

Massachusetts Highway

Department

The Lower North Shore Transportation Improvement Study

Project Manager
Chen-Yuan Wang
Jim Gallagher

Contributing Staff
Tom Lisco
Efi Pagitsas
Susan Lincoln
Keith Bynum
Coleman McDonagh
Allison B. Wiener
Kate Wall

Geographic Information Systems
Kathy Jacob
Mark Scannell
David Fargen
Jim Alberque

Graphics
Jane M. Gillis
Kate Parker

Photography
Carol Gautreau Bent

Cover Design
Jane M. Gillis

The preparation of this document was supported by the Massachusetts Highway Department and Federal Highway Administration through MHD Agreement SPR 97196.

Central Transportation Planning Staff
Directed by the Boston Metropolitan Planning Organization. The MPO is composed of state and regional agencies and authorities, and local governments.

October 2000

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

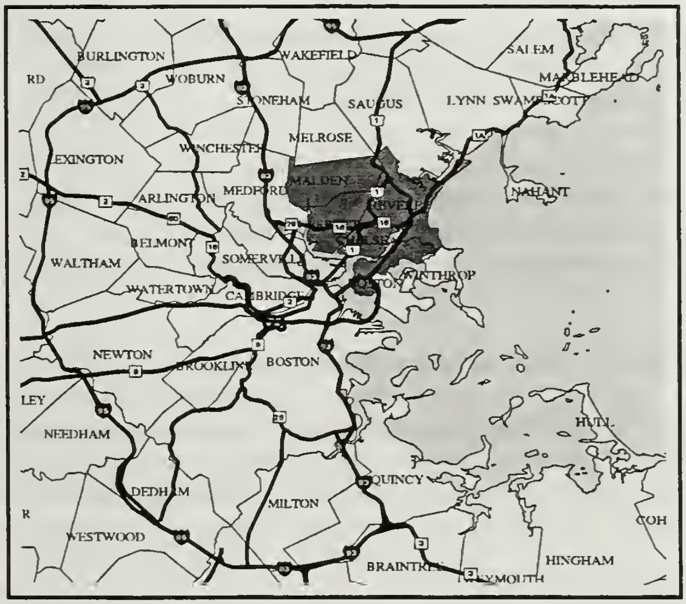
EXECUTIVE SUMMARY

Introduction

The Lower North Shore Transportation Improvement Study, a comprehensive multimodal planning study, was designed to identify and address existing and future transportation needs and issues related to roadway congestion, transit services, and bicycle and pedestrian safety.

The study began in the summer of 1997 after results from the 1996 Boston-region Congestion Management System (CMS) annual report had identified congestion on some of the lower North Shore's roadways and transit services and at several of its park-and-ride lots. The range of issues, number of transportation options, and variety of possible improvements led to a recommendation in the 1996 CMS report that a multimodal, subarea "mobility" study be conducted for this area. Several other recent and ongoing planning studies have covered some of the same facilities and services as the present study, but none has examined the study area as comprehensively. The data collected, improvements recommended, and models developed in the other efforts were incorporated into this study to ensure that a consistent, comprehensive assessment of the area's transportation conditions was achieved.

Figure 1
Lower North Shore Study Area



The study area covers five communities on the lower North Shore: Chelsea, East Boston, Everett, Malden, and Revere (Figure 1). In the case of East Boston, Massport property is not included in the study area.

Study Objectives

The objectives of this study were:

- To identify where and how mobility can be improved in the lower North Shore study area.
- To develop and recommend a range of appropriate mobility improvements, including short- and long-range options, multimodal alternatives, and both improvements that utilize existing services and improvements that provide new services.

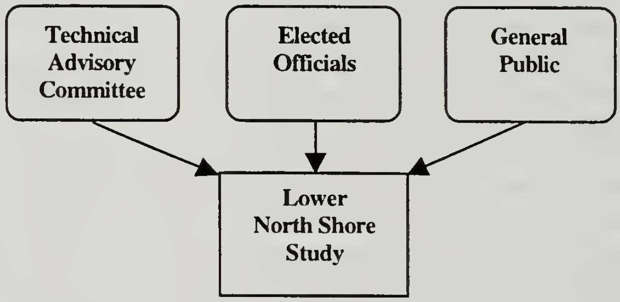
An important element in the study's pursuit of these objectives was a comprehensive public outreach program that made information about the project available to all area residents and users of the transportation system and gave them the opportunity to contribute to the identification of needs and potential improvements.

Public Involvement

The Lower North Shore Transportation Improvement Study had many key players (Figure 2). A Technical Advisory Committee (TAC), composed of planners and engineers from each of the five communities along with staff from the key implementing state agencies, was created to provide expert advice and guidance throughout the study. The key state agencies represented on the TAC were the Massachusetts Highway Department (MassHighway), which was the project's sponsor, and the Massachusetts Bay Transportation Authority (MBTA), Massachusetts District Commission (MDC), Massachusetts Port Authority (Massport), and Metropolitan Area Planning Council (MAPC). The Central Transportation Planning Staff (CTPS) carried out the study. TAC members met regularly to help identify transportation needs and suggest appropriate alternatives to be evaluated. Active involvement of the five communities' state senators, state representatives, and mayors was encouraged.

In addition to TAC members, the general public played an important role in identifying transportation needs and priorities. Public meetings were held in each of the participating communities in November 1997 to solicit comments and opinions on transportation issues. Additional public meetings were held in November 1998 to invite comments on proposed improvement alternatives. The final recommendations were presented at public meetings in December 1999.

Figure 2
Key Players in the Study



Existing Transportation System

The five study area communities have an urban transportation system consistent with the facilities in other inner core communities that surround the city of Boston. Expressways, rapid transit lines, commuter rail lines, and buses transport large numbers of travelers into, out of, and through the study area each day.

U.S. Route 1 and Route 1A are the two major north-south roadways. They link the North Shore communities to Boston. Route 1 is the only limited-access highway; it serves about 87,000 vehicles daily. Route 1A hugs the coast east of Route 1 and carries about 54,000 vehicles daily. Two secondary north-south facilities, Route 99 and Route 107, each carry about 30,000 vehicles daily.

Route 60 and Route 16 (Revere Beach Parkway) are the major east-west routes in the study area. Route 60's busiest section, east of Route 1, serves about 46,000 vehicles daily. Daily traffic on Route 16 ranges from about 56,000 vehicles through Everett to 18,000 vehicles through Revere.

In the study area, congestion on Route 1 mainly occurs in the section north of Copeland Circle. Route 1 is a six-lane facility south of Route 60, but only four lanes north of Route 60. At the point on Route 1 northbound where three lanes transition to two lanes, traffic demand exceeds capacity, causing congestion on a daily basis. Recurring congestion also occurs on Route 1 southbound at the Route 60 off-ramp during the AM peak period and on Route 1 northbound at the Route 60 on-ramp during the PM peak period.

The present interchange between Route 1 and Route 16 lacks connections between Route 1 to the north and Route 16 to the east. Therefore, all traffic between Route 1 north and destinations such as Revere

Beach and Logan Airport must use Copeland Circle and Route 60. New connections at Route 1/Route 16 may alleviate some of the congestion on Route 60 by providing motorists with an alternate route.

Many of the area's major junctions are traffic rotaries. Copeland Circle (Route 1/Route 60), Brown Circle (Route 60/Route 107), and Butler Circle (Route 1A/North Shore Road), located in Revere, and Santilli Circle (Route 16/Santilli Highway) and Sweetzer Circle (Route 16/Route 99), located in Everett, are presently unsignalized. Mahoney Circle (Route 1A/Route 60/Route 16), located in Revere, has been signalized on the approaches to accommodate high traffic demand.

Transit is an important part of the area's transportation system. Rapid transit plays a dominant role. Two rapid transit lines—the Blue Line and the Orange Line—serve the study area. Two commuter rail lines, extending from North Station to Ipswich and Haverhill, each stop once in the study area, but pick up fewer passengers than rapid transit. Commuter boat service is available from East Boston (at Logan Airport) to Rowes Wharf in Boston.

Over 30 bus routes are located either entirely or partially in the study area. Many of the routes terminate at rapid transit stations for transferring to further destinations. Four routes have direct service to downtown Boston. Some of the routes are also used to serve local trips within or between neighborhoods.

Issues Selected for Further Study

A number of transportation issues were identified for which CTPS would perform detailed analyses and develop potential improvements. These issues, listed below, were identified based on comments received from TAC members and from citizens at the public meetings, and based on the analysis of existing conditions.

- Connections between Route 1 and Route 1A - East-west connections between Route 1 and Route 1A in Revere either are missing, such as connections between Route 1 north and Route 16 east, or are heavily congested during peak travel periods, which is the case with Route 60 and Route 16. The analysis looked at new ramp connections for the Route 1/Route 16 interchange and at upgrading operations and reducing delays along Route 16 and Route 60 between Mahoney Circle (Route 1A) and Route 1 (also see the issue of signal coordination along Route 16, below).

- Route 1 north of Copeland Circle - Route 1 is generally a six-lane facility in the study area, but the section between Copeland Circle and Route 99 has only four lanes. Congestion occurs daily on this section. In addition, traffic operations are unsafe at the on- and off-ramps of the Salem Street/Lynn Street interchange, largely due to the ramps' geometric limitations, including the absence of deceleration and acceleration lanes, the tight turning radii, and the close proximity of adjacent ramps. The analysis reviewed add-a-lane options for relieving congestion on this section of Route 1, and looked at closing or redesigning the Salem Street/Lynn Street ramps to improve safety and traffic operations.

- Truck connections - The analysis responded to citizens' and local officials' complaints about truck traffic impacts in Everett, Chelsea, and East Boston. More direct and easier connections for trucks between Logan Airport, Route 1 north, and the industrial centers of Chelsea and Everett were investigated.

- Traffic management - The analysis investigated possible traffic management measures for Revere Beach Boulevard in Revere and Hancock Street in Everett. This analysis was a direct result of citizen complaints made at the public meetings about cut-through traffic and speeding vehicles and the resulting danger to pedestrians, bicyclists, and turning vehicles along these two roadways.

- Congested signalized intersections - Traffic operations at a number of congested intersections may be improved by signal retiming or by other modifications. The following intersections were selected for study:

  - Bennington Street @ Saratoga Street, East Boston
  - Main Street @ Tileston Street/Oakes Street, Everett
  - Bennington Street/State Road @ Winthrop Avenue, Revere
  - Route 16 @ Winthrop Avenue/Harris Street, Revere
  - Route 1A @ Revere Street, Revere
  - Route 1A @ Beach Street, Revere
  - Route 60 @ Revere Street, Revere

- Signal coordination along Route 16 - Travel time and delay runs on Route 16 in the study area revealed that traffic moved slowly on this major east-west facility during both the AM and PM peak periods. The analysis aimed to improve peak period traffic operations on side street approaches and along Route 16 by integrating signals into a coordinated system. The portion of Route 16 examined for signal coordination lies between Lewis Street in Everett and Webster Street/Garfield Street in Chelsea.

- Pedestrian safety - Pedestrian safety studies were conducted for four intersections identified from the accident analysis and from comments made at the public meetings:

  - Revere Beach Boulevard @ Oak Island Road, Revere
  - Route 107 @ Central Avenue, Revere
  - Route 99 @ Ferry Street, Everett
  - Bennington Street @ Saratoga Street, East Boston

- Crowded parking lot at Wonderland Station - The foundation for the analysis of the issue of crowding at the Wonderland Station parking lot was a license plate survey determining where the commuters parking there are originating. Strategically located satellite facilities would help alleviate parking pressures at the station, where parking presently overflows onto Revere Beach Parkway, and reduce traffic demands on Route 1, Route 60, Revere Street, and other roadways in between.

Development and Analysis of Improvement Alternatives

Searching for improvements that address the identified transportation issues was the major effort of this study. For issues such as traffic management, congested signalized intersections, signal coordination along Route 16, pedestrian safety, and the crowded parking lot at Wonderland Station, the study developed improvements that can be implemented in the short term (within three years). The study analyzed the proposed improvements using highway capacity analysis, accident data analysis, and other traffic analysis techniques.

For issues that involve regional traffic, such as connections between Route 1 and Route 1A, congestion on Route 1 north of Copeland Circle, and truck connections, the study developed long-range improvement alternatives (improvements requiring more than three years for implementation). In order to ascertain the extent of future travel demand and whether the demand can be accommodated by the proposed long-range alternatives, this study developed a future-year (2020) travel demand forecasting model to test different scenarios. Using traffic volumes predicted by the model scenarios, the study estimated the effects of the long-range alternatives on travel patterns in the study area and on the levels of service of new signalized intersections.

Based on analyses of the various alternatives and on discussions with the TAC members, the general public, and the operating agencies, the study then recommended a number of short-range and long-range improvements.

Recommended Short-Range Improvements

The recommended short-range improvements comprise a traffic management plan for Hancock Street in Everett, a traffic management plan for Revere Beach Boulevard in Revere, improvements at seven congested signalized intersections, a signal coordination plan for Route 16 in Chelsea and Everett, and pedestrian safety improvements at three intersections in the study area.

Hancock Street Traffic Management, Everett

Citizens at the Everett public meeting expressed concern of frequent speeding on Hancock Street. The speeding is attributable to the roadway's high design speed, unintentionally engineered. The roadway is straight and has relatively few traffic control devices. Although the roadway is only 32.5 feet wide, the uniformity of all of the parking spaces being located on the same side (the north side) of the street makes it appear wider.

The study developed three alternatives, each building on the previous one. The final set of recommended measures, which favors Alternative 3's set, is to provide contrasting crosswalks, convert High Street to one-way operation, rearrange street parking, provide bulb-outs at intersections, and expand sidewalks in the commercial area.

Revere Beach Boulevard Traffic Management, Revere

Vehicle speeding and "cruising" on Revere Beach Boulevard, and related concerns of pedestrian safety were voiced at the Revere public meeting. Pedestrian activity is high along and across the boulevard that runs north-south alongside the Revere beach for approximately three miles. It is a recreational roadway with year-round activity, although usage increases substantially during the summer months.

The study developed a set of traffic management measures that received many favorable responses at the public meetings. These measures are to install warning signs at, and to narrow, the gateways (entrances to the boulevard), to provide neckdowns at pedestrian crossing areas, to make crosswalks prominent, to extend the beach sidewalk north of Revere Street via conversion of angle parking to parallel parking, and to extend MBTA bus route(s) to new stops on the boulevard north of Oak Island Street.

Congested Signalized Intersections

The study examined seven congested intersections in the study area as candidates for traffic signal retiming. Retiming and, in some cases, a signal system upgrade or geometric modifications are recommended for these intersections except the intersection of Route 60 at Revere Street in Revere. The intersection capacity analysis indicated that this intersection's traffic volumes are above capacity and that signal timing adjustments alone cannot reduce the congestion. The only options are to add more lanes or to divert traffic to another travel path. The study assumed that, upon completion of the Mahoney Circle project, the number of Route 60 southbound left turns onto Revere Street would decrease and the signal could be retimed to operate more efficiently.

Route 16 (Revere Beach Parkway) Signal Coordination

The study recommends signal coordination for the intersections of Revere Beach Parkway at Lewis Street, Second Street, Spring Street, South Ferry Street, Vine Street, Vale Street, Everett Avenue,

Washington Street, and Garfield/Webster Street. A preliminary traffic signal analysis shows that it is possible to provide improved service on Revere Beach Parkway with signal coordination. However, adjusting the traffic signals would negatively affect some cross streets unless changes are made to their approaches as well. Everett Street, Washington Street, and Garfield/Webster streets would require the addition of a separate left-turn lane. The intersection of Revere Beach Parkway at Second Street requires major reconstruction in order to provide acceptable traffic signal operations, due to the high traffic volumes. Providing left-turn lanes on Second Street and a right-turn lane on Revere Beach Parkway eastbound would result in a good level of service.

Pedestrian Safety Improvements

The study examined four intersections in the study area as candidates for pedestrian safety improvements and recommends such improvements for three of them. The recommendations include the following: for Bennington Street at Saratoga Street (East Boston), lengthening the pedestrian phase, extending a corner to shorten the crossing distance, providing better enforcement of the prohibition of right turns on red, and installing a sign explaining the "Walk/Don't Walk" indications; for Revere Beach Boulevard at Oak Island Street (Revere), providing "neckdowns" at certain pedestrian crossing areas and installing new pedestrian signals; for Broadway (Route 107) at Central Avenue (Revere), installing full traffic signal operation with an exclusive pedestrian phase, restriping the crosswalks, and providing a wheelchair ramp at the southeast corner. The study makes no recommendations for the intersection of Route 99 at Ferry Street (Everett), as it is fully equipped with working pedestrian devices.

Recommended Long-Range Improvements

Due to the lack of appropriate connections between Route 1 and Route 1A via Route 16, regional traffic traveling between Route 1 north (North Shore area) and Route 1A south (Boston, including Logan Airport) currently must go through the center of Revere, using Route 60 and Route 1A. To redirect this traffic away from the center of the city, the study recommends new or improved connections at three locations: at the Route 1/Route 16 interchange, between Route 1A and Route 16, and on Route 1 north of Copeland Circle. In addition, the study recommends a new connection between Route 1A and the Chelsea Street Bridge to improve the flow of truck traffic between Logan Airport/Boston and Chelsea. To improve traffic conditions of Route 60 in Revere, the study proposes improvements at Brown Circle (Route 60/Route 107 junction) and along the Route 60 corridor between Brown Circle and Copeland Circle. The study also supports the Blue Line extension and favors water transportation in the study area.

Route 1/Route 16 Interchange

Currently, there is no direct connection from Route 16 westbound to Route 1 northbound or from Route 1 southbound to Route 16 eastbound. Five alternatives that complete these connections were analyzed. Alternatives 1, 2, and 2 Revised involve at least one new signal on Route 16, while Alternatives 3 and 4 provide complete grade separation for all movements. The recommended improvement is Alternative 2 Revised, which combines signalized double left-turn lanes from Route 1 southbound with a standard on-ramp from Route 16 westbound to Route 1 northbound. This ramp would require taking the land occupied by a restaurant (the exact right-of-way would be determined in the final design). Alternative 3 would preserve the restaurant, but its estimated cost is $7.3 million, whereas that of the recommended alternative is $3.9 million.

New Route 1A and Route 16 Connection

The study developed and evaluated four alternatives for Route 16/1A connections. Alternative 1, a minimum-build option providing for left turns at the existing interchange of Route 1A and Route

145/Revere Beach Parkway, is already planned for implementation, as an outcome of the Mahoney Circle Grade Separation Feasibility Study completed in June 1997. It provides two new signalized median breaks on Route 145/Revere Beach Parkway to allow for left turns from Route 1A northbound to Revere Beach Parkway westbound and from Revere Beach Parkway westbound to route 1A southbound.

Alternative 2, flyover ramps between Routes 1A and 16, provides a direct connection for two currently difficult moves: Route 1A northbound to Route 16 westbound and Route 16 eastbound to Route 1A southbound. This alternative provides improved connections between the tunnels/Logan Airport and Route 1 but does not improve access to Revere Beach.

Alternative 3 provides a new direct connection between Routes 1 and 1A via Route 16, creates a gateway to Revere Beach by relocating Route 16 to the southeast, and should divert a significant amount of traffic away from Mahoney Circle. However, this design includes a new diamond (signalized) interchange that may not be able to handle the heavy traffic volumes forecasted.

Alternative 4 is the recommended alternative. It upgrades Alternative 3 by providing full grade separation for all of the important movements via a three-fourths cloverleaf design. Although this is the most expensive alternative (estimated construction cost: $39.6 million), requires the most land takings, and is the most visually imposing design, it is the only one which would accommodate a major redevelopment at Suffolk Downs plus other expected growth in the corridor. The "green" aspects of the alternative, including new parks with pedestrian/bicycle paths and waterfront access, are important components that should be included in any final design.

Route 1, North of Copeland Circle

The study developed three alternatives, ranging from a minimum level of investment to major reconstruction of Route 1 between Copeland Circle and Route 99. Alternative 1 proposes closing three of the existing ramps at the Salem Street/Lynn Street interchange, minor redesign of the northbound on-ramp, minor changes on Salem Street, and designation of the existing climbing lane as a third travel lane.

Alternative 2 proposes to add a third lane in both directions between Copeland Circle and the Salem Street/Lynn Street interchange. The existing Route 1 bridge, located between Copeland Circle and the interchange over the railroad right-of-way, would be rebuilt, and the ramps at that interchange would be reconfigured.

Alternative 3 provides for complete reconstruction of the Salem Street and Route 99 interchanges and the addition of a third lane on Route 1 throughout the segment between Copeland Circle and the Route 99 interchange.

The study recommends both minor and major improvements. To make immediate improvements to the safety of the Salem Street/Lynn Street interchange, Alternative 1 is recommended; the construction cost is estimated as just $235,000. Long term, to reduce the congestion on Route 1, particularly if Rowes Quarry is redeveloped, Alternative 3 is recommended; the construction cost is estimated as $33.6 million.

New Route 1A/Chelsea Street Bridge Connection

Lack of good access to Chelsea from Route 1A and Logan Airport, and the presence of regional trucks on local Chelsea streets, were two major concerns expressed by Chelsea. The Chelsea Street Bridge Connector, which provides direct access between the new Chelsea Bridge and Route 1A, is designed to address both problems and is the recommended improvement. It not only would improve access to

Chelsea and provide a direct path for trucks, but would also draw traffic away from Day Square in East Boston, which all Chelsea-bound traffic must currently use. In addition, this new connection could improve the flow of air freight traffic between Logan Airport and Chelsea.

Brown Circle

Brown Circle, the rotary at the intersection of Route 107 and Route 60, is the scene of frequent accidents and congestion. The study proposed two alternatives for improving operations: grade separation of Route 60 through traffic and conversion of the rotary to a signalized intersection. The signal alternative is recommended, as it would require little or no right-of-way acquisition and would improve the safety of the intersection. However, this recommendation is based on the condition that the connections between Route 1 and Route 1A would have been improved and the future (2020) travel demand at this location would not exceed the present level. Otherwise, the grade separation or other options should be considered and further study of this location should be conducted.

Route 60 Corridor between Brown Circle and Copeland Circle

The study reviewed two alternatives for improving operations along this corridor. Alternative 1, proposed in conjunction with the signalization of Brown Circle, is the recommended alternative. Its main feature is the coordination of traffic signals between Revere Street and Copeland Circle. Alternative 2 is proposed as an accompaniment to the Brown Circle grade separation. Its main features include eliminating two traffic signals, relocating access to Northgate Shopping Center, and closing the Route 60 median.

Blue Line Extension

Part of the reason for the congestion at Mahoney Circle, and a major cause of the cut-through traffic on Revere Street, is vehicles heading for the parking lots serving Wonderland Station, the last stop on the Blue Line. Parking surveys done at Wonderland indicate that over half of all parked vehicles came from the north and accessed the site via the Route 1A bridge. A Blue Line extension—besides providing better transit service to northern communities and opportunities for economic development, particularly in Lynn—would remove some of the traffic traveling through Revere and possibly free up some parking areas for future development.

Extending the Blue Line has been under study by the MBTA, and money was allocated in the most recent federal transportation legislation, TEA-21, for a large-scale study of this and other alternatives on the North Shore. It is the recommendation of this study's member communities that these studies be completed with an eye to eventually extending the Blue Line at least to Lynn, possibly as far as Beverly. The member communities also recommend that these studies not include any alternatives which would eliminate the Chelsea commuter rail stop or the Wonderland Blue Line station.

Water Transportation in the Area

The city of Revere is investigating rebuilding the historic pier at Revere Beach. Both Revere and Chelsea are looking at increased use of waterborne transportation modes. This study's member communities recommend that all forms of water transportation be encouraged.

Conclusion

The study identified the mobility issues in the lower North Shore area, developed and analyzed mobility improvement alternatives, and recommended a range of short- and long-range improvements. All of the improvement alternatives presented in this report, including those being recommended, are in the form of preliminary conceptual plans suitable for the purposes of this study.

Prior to implementation of any of the improvements, it would be necessary to perform further engineering study, to conduct a more extensive public review, and to perform any required environmental reviews.

1 INTRODUCTION

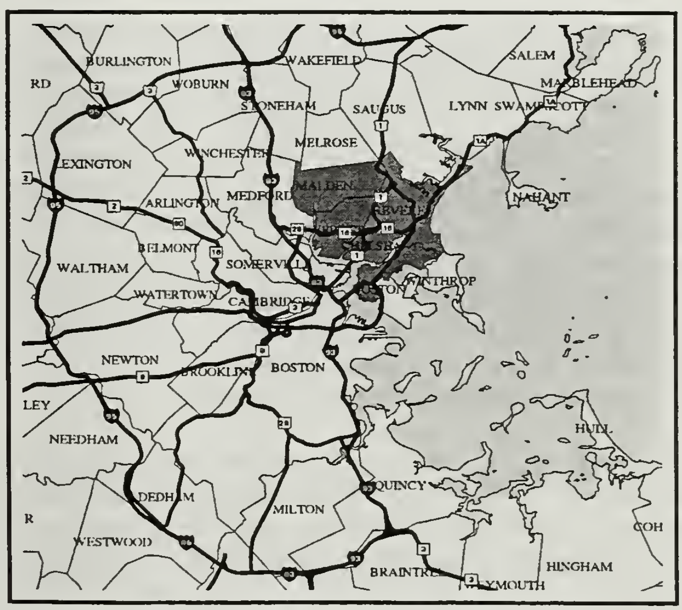
1.1 Background

The Lower North Shore Transportation Improvement Study, a comprehensive multimodal planning study, was designed to identify and address existing and future transportation needs and issues related to roadway congestion, transit services, and bicycle and pedestrian safety.

The study began in the summer of 1997 after results from the 1996 Boston-region Congestion Management System (CMS) annual report had identified congestion on some of the lower North Shore's roadways and transit services and at several of its park-and-ride lots.[1] Average travel speeds, used to monitor congestion, on the lower portion of Routes 1 and 1A were low. The Blue Line and the express and local bus routes that travel through the lower North Shore sometimes exceeded passenger-crowding standards, failed to perform on-time, or both. Park-and-ride lots at Wonderland, Sullivan Square, Suffolk Downs, and Orient Heights stations were often full, while the parking garage at the Lynn commuter rail station and the MassHighway lot in Chelsea (now closed) were underutilized.

The range of issues, number of transportation options, and variety of possible improvements led to a recommendation in the 1996 CMS report that a multimodal, subarea "mobility" study be conducted for this area. Several other recent and ongoing planning studies have covered some of the same facilities and services as the present study, but none has examined the study area as comprehensively. The data collected, improvements recommended, and models developed in the other efforts were incorporated into this study to ensure that a consistent, comprehensive assessment of the area's transportation conditions was achieved.

Figure 1-1
Lower North Shore Study Area



1.2 Study Area

The study area covers five communities on the lower North Shore: Chelsea, East Boston, Everett, Malden, and Revere (Figure 1-1). In the case of East Boston, Massport property is not included in the study area.

[1] The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 mandated the development and implementation of a Congestion Management System (CMS) in each metropolitan area with a population of 200,000 or more. The Boston Metropolitan Planning Organization (MPO), as part of its CMS implementation effort, prepared the first annual report on mobility in the MPO region in 1996. The report described existing conditions for roadways, MBTA transit services, and park-and-ride lots and used this information to identify problem areas in the region.

1.3 Study Objectives

The objectives of this study were:

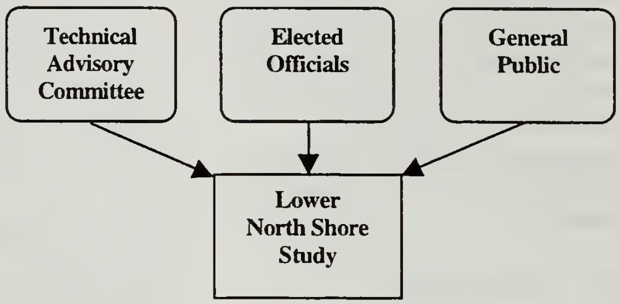
- To identify where and how mobility can be improved in the lower North Shore study area.
- To develop and recommend a range of appropriate mobility improvements, including short- and long-range options, multimodal alternatives, and both improvements that utilize existing services and improvements that provide new services.

An important element in the study's pursuit of these objectives was a comprehensive public outreach program that made information about the project available to all area residents and users of the transportation system and gave them the opportunity to contribute to the identification of needs and potential improvements.

1.4 Public Involvement

The lower North Shore Transportation Improvement Study had many key players (Figure 1-2). A Technical Advisory Committee (TAC), composed of planners and engineers from each of the five communities along with staff from the key implementing state agencies, was created to provide expert advice and guidance throughout the study. The key state agencies represented on the TAC were the Massachusetts Highway Department (MassHighway), which was the project's sponsor, and the Massachusetts Bay Transportation Authority (MBTA), Massachusetts District Commission (MDC), Massachusetts Port Authority (Massport), and Metropolitan Area Planning Council (MAPC). The Central Transportation Planning Staff (CTPS) carried out the study. TAC members met regularly to help identify transportation needs and suggest appropriate alternatives to be evaluated. A total of 12 TAC meetings were conducted during the course of the study.

Figure 1-2
Key Players in the Study



Active involvement of the five communities' state senators, state representatives, and mayors was encouraged. Elected officials received invitations to all TAC and public meetings. Study products, including draft reports and technical memorandums, were also sent to them for their review and comment.

The general public played an important role in identifying transportation needs and priorities. Public meetings were held in each of the participating communities in November 1997 to solicit comments and opinions on transportation issues. Additional public meetings were held in November 1998 to invite comments on proposed improvement alternatives. The final recommendations were presented at public meetings in December 1999. The comments received at public meetings are summarized in Appendix A: Public Involvement.

1.5 Report Organization

During the course of the study, extensive data collection and analysis, 12 TAC meetings, and three rounds of public meetings produced a wealth of information. The study is therefore documented in two volumes: the present volume and a volume of appendices, the latter primarily presenting material that is more technical. The content of each volume is described below.

In the present volume, this introductory chapter is followed by five chapters. Chapter 2, Overview of Existing Conditions, includes five sections. The first presents an overview of the area's transportation services and how they interact with the larger regional transportation system. The second through fourth summarize existing conditions for roadways, transit services, and bicycle and pedestrian safety, respectively. The last describes the transportation needs to be addressed in this study, identified from the existing conditions analysis and comments received from TAC members and the general public.

Chapter 3, Short-Range Alternatives, presents improvement alternatives that do not involve major reconstruction or require a long planning and design process. These improvements include Hancock Street (in Everett) traffic management, Revere Beach Boulevard traffic management, suggestions for several congested signalized intersections, Revere Beach Parkway signal coordination, and pedestrian safety improvements for four locations in the study area.

Chapter 4, Long-Range Alternatives, presents improvement alternatives that involve major reconstruction and require a long planning and design process. The chapter is organized by location. These locations are the Route 1/Route 16 interchange, new Route 1A and Route 16 connections, Route 1 north of Copeland Circle, a new Route 1A/Chelsea Bridge connection, Brown Circle, and the Route 60 corridor between Brown Circle and Copeland Circle.

Chapter 5, Travel Demand Forecasts, estimates what the impacts would be of certain combinations, or "packages," of long-range alternatives. The chapter describes how the travel demand forecasting models were developed. Based on the predicted future traffic volumes from the models of various alternative packages, it summarizes the study area travel-demand patterns and gives forecasts of the level of service at new signalized intersections.

Chapter 6, Recommendations, describes the improvements recommended for implementation in the short term and in the long term. The chapter also includes an outline of steps that communities can take to work with implementing state agencies to proceed the recommended improvements.

In the separately bound volume of appendices, Appendix A describes the study's key players and its process for public involvement, summarizes the comments made at public meetings, and reproduces the written comments received from the public. Appendices B through H document and analyze the existing conditions for the various transportation modes in the study area. Appendix I describes how the future-year (2020) travel demand forecasting models were developed and includes projections of households and employees in the study area. Appendix J is a collection of the minutes of the 12 TAC meetings held over the course of the study.

2 OVERVIEW OF EXISTING CONDITIONS

2.1 Study Area Transportation System

The five study area communities have an urban transportation system consistent with the facilities in other inner core communities that surround the city of Boston. Expressways, rapid transit lines, commuter rail lines, and buses transport large numbers of travelers into, out of, and through the study area each day.

The primary elements of the study area's transportation network are shown in Figure 2-1. U.S. Route 1 and Route 1A are the two major north-south roadways. They link the North Shore communities to Boston. Route 1 is the only limited-access highway; it serves about 87,000 vehicles daily. Route 1A hugs the coast east of Route 1 and carries about 54,000 vehicles daily. Two secondary north-south facilities, Route 99 and Route 107, each carry about 30,000 vehicles daily.

Route 60 and Route 16 (Revere Beach Parkway) are the major east-west routes in the study area. Route 60's busiest section, east of Route 1, serves about 46,000 vehicles daily. Daily traffic on Route 16 ranges from about 56,000 vehicles through Everett to 18,000 vehicles through Revere.

Many of the area's major junctions are traffic rotaries. Copeland Circle (Route 1/Route 60), Brown Circle (Route 60/Route 107), and Butler Circle (Route 1A/North Shore Road), located in Revere, and Santilli Circle (Route 16/Santilli Highway) and Sweetzer Circle (Route 16/Route 99), located in Everett, are presently unsignalized. Mahoney, or Bell, Circle (Route 1A/Route 60/Route 16), located in Revere, has been signalized on the approaches to accommodate high traffic demand.

Transit is an important part of the area's transportation system. Rapid transit plays a dominant role. Two rapid transit lines—the Blue Line and the Orange Line—serve the study area. Two commuter rail lines, extending from North Station to Ipswich and Haverhill, each stop once in the study area, but pick up fewer passengers than rapid transit. Commuter boat service is available from East Boston (at Logan Airport) to Rowes Wharf in Boston.

Over 30 bus routes are located either entirely or partially in the study area. Many of the routes terminate at rapid transit stations for transferring to further destinations. Only four routes have direct service to downtown Boston. Other routes are designated to serve local trips within or between neighborhoods.

2.2 Roadway Issues

2.2.1 U.S. Route 1 Congestion

The expressway portion of U.S. Route 1 extends from I-93 (the Central Artery), in the south, to I-95/Route 128, in the north. The roadway continues as a principal arterial north to New Hampshire. Originally built in the 1930s, some of Route 1's ramps and mainline sections fail to meet current federal design standards. Both Malden and Chelsea requested improvement of the geometry of Route 1 where feasible when this study began.

Average weekday traffic volumes in 1997 on Route 1 ranged from about 76,000 vehicles over the Tobin Bridge to 99,000 vehicles at the Malden/Saugus line. Traffic volumes on Route 1 are higher north of Route 60 (Copeland Circle). Route 60 serves as the major east-west connector between towns north of Malden and the coast, Logan Airport, and Wonderland Station. Wonderland Station is the last stop on the Blue Line and, with over 1,200 parking spaces, is a major attractor of trips in the region.

In the study area, congestion on Route 1 mainly occurs in the section north of Copeland Circle. Route 1 is a six-lane facility south of Route 60, but only four lanes north of Route 60. At the point on Route 1 northbound where three lanes transition to two lanes, traffic demand exceeds capacity, causing congestion on a daily basis. Recurring congestion also occurs on Route 1 southbound at the Route 60 off-ramp during the AM peak period (when traffic from the north is traveling towards Route 1A) and on Route 1 northbound at the Route 60 on-ramp during the PM peak period (when traffic is traveling from Route 1A to Malden and other towns to the north).

Route 60 is not the only east-west route intersecting Route 1 in Revere: to the south is the change with Route 16 (Revere Beach Parkway). However, the present interchange between Route 1 and Route 16 lacks connections between Route 16 to the east and Route 1 to the north. Therefore, all traffic between Route 1 north and destinations such as Revere Beach and Logan Airport must use Copeland Circle and Route 60. New connections at Route 1/Route 16 may alleviate some of the congestion on Route 60 by providing motorists with an alternate route. Completing these connections was one of the major transportation issues submitted by Revere at the outset of this study.

Traffic problems also exist on Route 1 at the Salem Street/Lynn Street off- and on-ramps in Malden. Even though the volumes of the traffic using these ramps are not high, traffic operations are poor. This deficiency is largely due to the ramps' geometric limitations, including the absence of deceleration and acceleration lanes along Route 1, low design speeds, and the close spacing of the ramps.

South of Route 60, traffic flows freely on Route 1 northbound and southbound during both the AM and PM peak periods. The only congestion occurs on Route 1 southbound through Charlestown, where vehicles are delayed by the merge of Route 1 traffic with I-93 traffic south of the Tobin Bridge tolls.

2.2.2 Arterial Congestion

Arterial congestion was measured by average travel speeds. The speeds were derived from travel times: about 25 travel time runs were conducted on five study area roadways—Routes 1A, 16, 60, 99 and 107—during the morning and evening peak periods. The results are presented in Figure 2-2 for the AM peak period and Figure 2-3 for the PM peak period. Roadway segments with average speeds consistently below 15 mph were categorized as congested.

In the Boston region in general, congestion occurs on roadway segments directed inbound to Boston during the AM peak period and outbound during the PM peak period. Route 1A north of Route 60 is one roadway section that clearly follows this pattern. Route 60 between Route 1 and Route 1A also shows a dramatic directional disparity. Here, the slower peak-direction speeds were measured eastbound during the AM peak period and westbound during the PM peak period. Route 1 traffic operations at Copeland Circle, discussed in the previous section, also show peak-direction congestion patterns.

Many arterials in the study area, however, are congested in both directions during the AM and PM peak periods. Sections of Route 16 through Chelsea and Everett, Route 60 between Route 99 and downtown Malden, Route 99 through Everett, Route 107 through Chelsea and Revere, and three out of the four approaches to Mahoney Circle all have slow travel speeds during both peak periods.

Slow speeds on arterials are largely attributable to congestion at intersections. The following section provides details on this source of congestion problems.

2.2.3 Intersection Congestion

Both CTPS staff and TAC members agreed that 67 signalized and unsignalized intersections were problematic and needed to be studied. Of the 67 intersections analyzed, 42 were found to have

FIGURE 2–1

Lower North Shore
Transportation Improvement Study

Study Area Transportation System

- Active rail
- Inactive rail
- Commuter line
- Orange Line
- Blue Line
- Green Line
- Red Line
- Commuter rail station
- Transit station
- Park-and-ride lot
- Interstate or Maj. Prin. Arterial
- Other func. classified rds.
- Town boundary

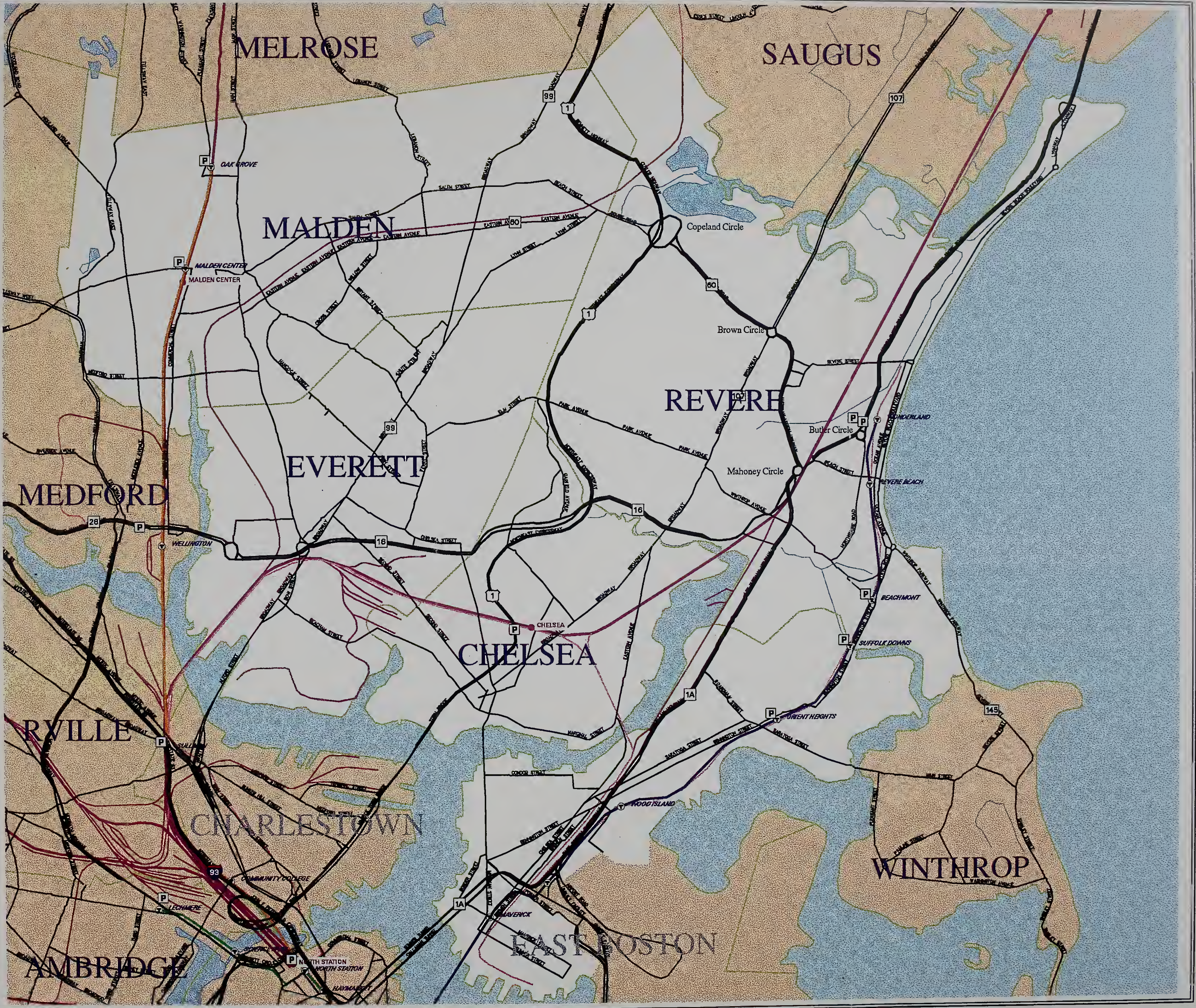


FIGURE 2 -2

Lower North Shore
Transportation Improvement Study

AM Peak Period
Average Travel Speeds

Route 1 (1994)
Route 1A (1995)
Route 16 (1995)
Route 60 (1996 - 97)
Route 99 (1996 - 97)
Route 107 (1997)

KEY

1 - 9 mph	
10 - 15 mph	
16 - 20 mph	
21 - 25 mph	
26 - 34 mph	
35+ mph	

FIGURE 2 -3

Lower North Shore
Transportation Improvement Study

PM Peak Period
Average Travel Speeds

Route 1 (1994)
Route 1A (1995)
Route 16 (1995)
Route 60 (1996 - 97)
Route 99 (1996 - 97)
Route 107 (1997)

KEY

1 - 9 mph
10 - 15 mph
16 - 20 mph
21 - 25 mph
26 - 34 mph
35+ mph

one or more congested movements during the AM or PM peak hour. "Congested" is defined as level of service (LOS) E or F. LOS E represents the maximum traffic volume that the facility can handle. LOS F is the worst condition, in which traffic movement has completely broken down.

A map showing the locations of the congested intersections is provided as Figure 2-4. The map distinguishes between signalized and unsignalized intersections, and the intersections are labeled with reference numbers. Table 2-1 lists the congested intersections in reference-number order, indicates when each problem occurs (AM and/or PM peak hour), and briefly describes the reason for the congestion. (Reference numbers are used to help identify intersections in this report and in the appendices. A number was assigned to every study area intersection for which data were obtained.)

Table 2-1
Congested Intersections

No.	Town	Control[a]	Location	Problem Period		Description of Problem
				AM Peak Hour	PM Peak Hour	
2	Malden	S	Route 60 @ Commercial St	×	×	Left turns from WB Route 60 and from NB Commercial St are unable to find gaps.
3	Malden	S	Route 60 @ Jackson St		×	Jackson St approach is at capacity.
5	Malden	S	Route 60 @ Main St	×	×	Left turns from WB Route 60 and from NB Main St are unable to find gaps.
6	Malden	S	Route 60 @ Ferry St	×	×	NB Ferry St approach is at capacity.
7	Malden	S	Route 60 @ Route 99	×	×	All approaches are above capacity.
8	Malden	S	Route 99 @ Hunting St		×	NB and SB Route 99 approaches are above capacity.
9	Malden	U	Route 60 @ Lynn St		×	Left turns from EB Route 60 to NB Lynn St are above capacity.
11	Malden	S	Beach St @ Wesley St		×	WB Beach St and NB and SB Wesley St approaches are above capacity.
13	Revere	U	Route 60 @ Hutchinson St		×	Right turns from Hutchinson St are above capacity due to cut-through traffic.
14	Revere	S	Route 60 @ Revere St	×	×	All approaches are above capacity.
16	Everett	S	Route 16 @ Second St/Corey St	×	×	EB Route 16 and NB Second St approaches are above capacity.
17	Everett	S	Route 16 @ Vine St	×	×	Left turns from NB and SB Vine St are unable to find gaps.
19	Everett	S	Route 16 @ Everett St	×	×	WB Route 16 and NB Everett St approaches are above capacity.
20	Chelsea	S	Route 16 @ Washington St	×	×	Left turns from NB and SB Washington St are unable to find gaps.
21	Chelsea	S	Route 16 @ Garfield Ave/ Webster Ave	×	×	NB and SB Webster St/Garfield Ave approaches are above capacity due to heavy left-turning volumes. Route 16 EB approach is above capacity.
24	Everett	S	Route 99 @ Second St	×	×	SB and NB Route 99 and EB Corey St approaches are above capacity.
25	Everett	S	Route 99 @ Chelsea St/ Norwood St	×	×	SB Route 99 approach is above capacity.
26	Everett	S	Route 99 @ Sea St/Shute St	×	×	SB Route 99 approach is above capacity.

No.	Town	Control[a]	Location	Problem Period		Description of Problem
				AM Peak Hour	PM Peak Hour	
27	Chelsea	U	Route 99 @ Cross St/Everett Ave		×	EB Everett Ave approach is above capacity.
37	Revere	S	Route 1A @ Revere St	×	×	NB and SB Route 1 approaches and left turns from EB Revere St are above capacity.
39	Revere	S	Bennington St/State Rd @ Winthrop Ave	×	×	SB State Rd and EB Winthrop Ave approaches are above capacity.
43	Everett	S	Route 16 @ Spring St	×		WB Route 16 approach is above capacity.
50	Chelsea	U	Carter St @ Route 1 SB on-/off-ramps	×	na[b]	Route 1 SB off-ramp traffic is above capacity.
55	Chelsea	U	Beach St @ Market St	×		EB and WB Market St approaches are above capacity.
60	Everett	S	Route 16 @ Lewis St	×		WB Route 16 approach is above capacity.
63	Everett	S	Route 99 @ Beacham St	×	×	Beacham St approach is at capacity.
65	Everett	S	Route 99 @ Dexter St	×		Dexter St approach is at capacity.
68	Everett	U	Route 99 @ Hancock St/High St		×	All turns from Hancock St unable to find gaps.
69	Everett	S	Route 99 @ Ferry St	×	×	NB and SB Broadway and EB Ferry St approaches are above capacity.
71	Everett	S	Main St @ Tileston St/ Oakes St	×	×	NB and SB Main St approaches are above capacity.
73	Everett	S	Ferry St @ Shute St/ Glendale St	×		SB Shute Stapproach is at capacity.
82	Revere	U	Brown Circle	×	×	All approaches at or above capacity.
84	Revere	S	Route 16 @ Winthrop Ave/Harris St	×	×	Winthrop Ave and Harris St have long delays due to long cycle length.
87	Revere	S	Route 1A @ Beach St	×	×	Beach St approach is at or above capacity.
90	East Boston	S	Route 1A @ Boardman St	×	×	All approaches are at or above capacity.
92	East Boston	U	Meridian St @ S. Central Sq		×	NB Meridian St approach is blocked by vehicles in S. Central Sq.
95	East Boston	S	Bennington St @ Saratoga St	×	×	SB Bennington St and EB Saratoga St approaches are above capacity.
97	East Boston	U	Meridian St @ Bennington St/Porter St	×	×	WB Bennington St and WB Porter St approaches are blocked by vehicles in S. Central Sq.
98	East Boston	S	Meridian St @ Saratoga St (Central Sq)		×	NB Meridian St approach is above capacity and EB Central Sq approach is blocked by vehicles exiting Saratoga St.
101	East Boston	S	Chelsea St @ Prescott St (Day Sq)		×	SB Prescott St approach is at capacity.
102	East Boston	U	Chelsea St @ Day Sq	×	×	All turns from NB Bennington St are unable to find gaps.
105	East Boston	U	Bennington St @ Bremen St	×	×	All turns from NB and SB Bremen St are unable to find gaps.

[a] S: Signalized; U: Unsignalized.

[b] na: data not available.

FIGURE 2–4

Lower North Shore
Transportation Improvement Study

Congested Intersections

Signalized intersection
Unsignalized intersection

Intersection numbers correspond
to the numbers used in the
text of this report.

2.2.4 Truck Traffic

Excessive truck traffic is a concern for several lower North Shore communities. In Chelsea, truck traffic impacts in residential neighborhoods are the most important transportation issue. Malden has concerns about too many trucks using Salem Street. Everett expressed concern about truck traffic on its major arterial, Route 99. Data provided by Everett show that truck traffic on Route 99 has increased from 5% to 12% or 13% since the toll increase at the Tobin Bridge.

2.3 Transit Issues

This section summarizes transit crowding and on-time performance problems for all transit services with stops in any of the five study area communities. Problems were identified by comparing actual vehicle crowding and on-time performance to the MBTA service standards.

2.3.1 Blue Line

During the AM and PM peak periods, 26% of all trips on the Blue Line are considered overcrowded, more than on the Orange or Red Line. The crowding standard for the Blue and Orange lines is no more than 2.25 passengers per seat during the peaks. The on-time performance of the Blue Line is 92%, three percentage points lower than the MBTA service standard. On-time is defined as operating within five minutes of the scheduled trip time.

2.3.2 Bus

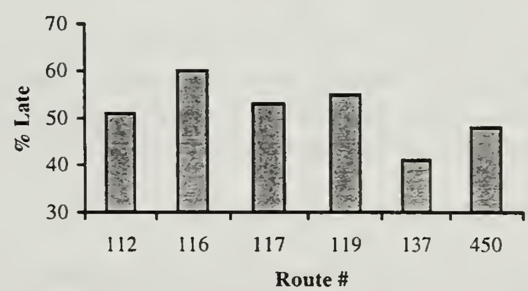
Four lower North Shore bus routes exceed the MBTA service standard for crowding during at least one time period (Table 2-2). The most crowded route is Route 117, between Wonderland and Maverick stations, with 1.55 passengers per seat during the AM peak period (the peak standard is 1.4 passengers per seat, the off-peak 1.0). Route 116, in the same Wonderland-to-Maverick corridor, also exceeds the standard in the AM peak. Route 136, with 1.5 passengers per seat outbound in the off-peak between Reading and Malden, and Route 101, between Malden and Sullivan Station, are the only other routes to exceed any crowding standard.

Table 2-2
Most Crowded Bus Routes

Rank	Route #
1	117
2	136
3	116
4	101

Route 117 and Route 116 also have poor on-time performance (Figure 2-5). Two bus routes that operate along Broadway in Chelsea have poor on-time performance: Route 119 and Route 450. Other lower North Shore bus routes with a high proportion of arrivals more than five minutes off schedule are Route 112, serving Wonderland and Maverick stations via Broadway in Everett, and Route 137, serving Malden Station and Reading Depot via Main Street in Malden, Melrose, and Wakefield.

Figure 2-5
Percentage of Bus Trips Arriving Late at Destination



2.3.3 Commuter Rail

During the AM and PM peak periods, only 11% of the trains into North Station exceed the MBTA crowding standard. The on-time performance of North Station trains is 88%, seven percentage points

below the standard. There is not enough information readily available to distinguish between individual commuter rail lines.

2.3.4 Commuter Boat

In 1997, there were no records of overcrowding on either the Charlestown or East Boston commuter boats. Of the peak period trips, 92% arrived on time, three percentage points below the MBTA service standard.

2.4 Bicycle and Pedestrian Safety

2.4.1 Demographics

Table 2-3 shows the number and percentage of people by community that bicycle or walk to work according to the 1990 U.S. Census Journey-to-Work survey. Chelsea has the highest percentage of bicycle trips and is above the average for the Boston MPO; Revere has the second-highest percentage in the study area. Everett and East Boston have few residents who bicycle to work.

Chelsea also has the highest percentage of people who walk to work. East Boston has the second highest. These rates could be due to the two cities' close proximity to downtown Boston, or their high population densities, or both.

In 1991, CTPS conducted a detailed household travel survey that included questions concerning trip purpose and travel mode. The survey results indicate that, of the total trips made by bicycle or by foot in the Boston MPO region, only 9% are work trips. When recreational, shopping, school, and other trip purposes are included, the number of bicycle and pedestrian trips increases tenfold. Assuming the lower North Shore communities exhibit the same characteristics as the region as a whole, the total numbers of bicycle and pedestrian trips may be 10 times those found in Table 2-3.

Table 2-3
People Bicycling or Walking to Work, 1990

	Bicycling		Walking	
Community	No.	%	No.	%
Chelsea	75	0.60	1,038	8.9
East Boston	13	0.09	1,096	7.6
Everett	8	0.05	958	5.5
Malden	37	0.13	1,226	4.5
Revere	51	0.25	839	4.2
Total	184	0.20	5,197	5.7
Boston MPO	8,843	0.40	116,474	5.6

2.4.2 Accidents

The most recent three years (1994–1996) of bicycle and pedestrian accident data was obtained for the study area from MassHighway and the Massachusetts Registry of Motor Vehicles (RMV). A total of 769 accidents were reported between 1994 and 1996; ten of the accidents resulted in a fatality.

Number of Accidents by Community

Table 2-4 shows the number of bicycle and pedestrian accidents by community and the rate per thousand residents. Chelsea's bicycle and pedestrian accident rates are higher than those of the other communities and considerably higher than the average for the Boston MPO region. Everett, a community that has a small number of bicycle work trips, has the second-highest bicycle accident rate. Revere, the community with the lowest number of pedestrian work trips, has the second-highest pedestrian accident rate.

Table 2-4
Bicycle and Pedestrian Accidents, 1994–96

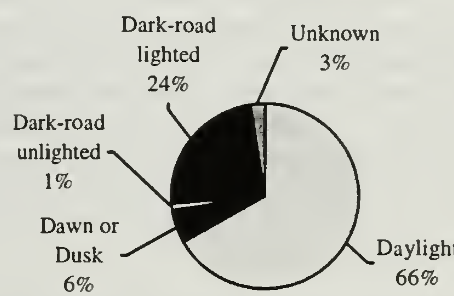
Community	1995 Population	Number of Bicycle Accidents	Bicycle Accidents per 1,000 Pop.	Number of Pedestrian Accidents	Pedestrian Accidents per 1,000 Pop.	Fatalities	
						Bicycle	Ped.
Chelsea	27,741	58	2.09	118	4.25	0	0
East Boston	32,941[a]	15	0.46	63	1.91	0	1
Everett	35,040	43	1.23	102	2.91	0	1
Malden	52,768	51	0.97	140	2.65	0	5
Revere	41,888	39	0.93	140	3.34	0	3
Total	190,378	206	1.08	563	2.96	0	10
Boston MPO	2,922,934	2,751	0.94	5,193	1.78	8	131

[a]1990 U.S. Census. Although the city of Boston experienced a 2.4% decrease in population between 1990 and 1995, no percent change was applied to East Boston population.

Light Conditions

Figure 2-6 shows percentage of accidents by light conditions. Sixty-six percent of the accidents occurred during daylight and 24% occurred during darkness on lighted roadways. Lack of light does not appear to be a major cause of accidents in the study area as a whole.

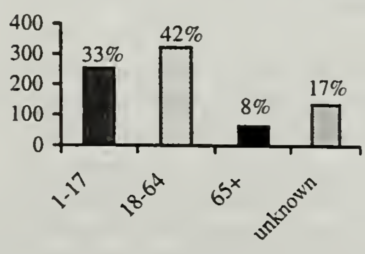
Figure 2-6
Percentage of Bicycle and Pedestrian Accidents by Light Conditions



Age

Figure 2-7 shows number of accidents by age. Forty-two percent of the accidents involved bicyclists or pedestrians aged 18 through 64, making that age range the largest category.

Figure 2-7
Number of Bicycle and Pedestrian Accidents by Age, 1994-96



Two communities, Chelsea and Everett, had as many accidents involving children (ages 1–17) as accidents involving adults (ages 18–64). In Chelsea, the reasons why so many children are involved in accidents are unknown. In Everett, children have some busy streets to cross. Nine schools, most of them elementary, are located on or near Broadway, the city's major arterial.

Operator Violations

Violations issued to the drivers of motor vehicles in connection with the accidents were investigated as part of the examination of causal factors. In 84% of the accidents, no violations were issued. In the remaining 16% of the accidents, a variety of violations were issued, including failure to grant right-of-way to a pedestrian (38%), leaving the scene of an accident (15%), driving under the influence of alcohol (10%), and "other" moving violations (13%).

Chelsea accounts for 33% of the violations issued, Revere for 28%. Few violations were issued in Everett or East Boston. Violations by location are dispersed throughout the study area. The roadways with the highest numbers of violations are Broadway (Route 107) through Chelsea and Revere (11%), Revere Beach Parkway (Route 16) through Revere, Chelsea, and Everett (6%), and Revere Beach Boulevard in Revere (6%).

Location

Bicycle accidents were generally spread throughout the study area. Downtown Chelsea and the vicinity of the intersection of Route 99 and Ferry Street in Everett showed a small degree of concentration. Clusters of pedestrian accidents were found at the following intersections:

- Revere Beach Boulevard @ Oak Island Road in Revere
- Route 107 @ Central Avenue in Revere
- Route 99 @ Ferry Street in Everett

As will be seen in the following section, the intersections that were selected for analysis of pedestrian safety as part of this study included, in addition to those listed above, Bennington Street @ Saratoga Street in East Boston. Residents at the East Boston public meeting, although RMV accident records show only three reported accidents in 1994–96, identified this intersection as unsafe for pedestrians.

2.5 Issues Selected for Further Study

Several transportation issues were identified for which CTPS would perform detailed analyses and develop potential improvements. These issues were identified based on comments received from TAC members and from citizens at the public meetings, and based on the technical analyses summarized in the appendices. These are issues that were not being specifically addressed in other studies or projects. A complete list of other studies and projects currently underway within the study area can be found in Appendix A.

These issues are:

- **Connections between Route 1 and Route 1A -** East-west connections between Route 1 and Route 1A in Revere are either missing, such as connections between Route 1 north and Route 16 east, or heavily congested during peak travel periods, such as Route 60 and Route 16. The analysis looks at new ramp connections for the Route 1/Route 16 interchange and at upgrading operations and reducing delays along Route 16 and Route 60 between Mahoney Circle (Route 1A) and Route 1 (also see the issue of signal coordination along Route 16, below).

- **Route 1 north of Copeland Circle -** Route 1 is generally a six-lane facility in the study area, but the section between Copeland Circle and Route 99 contains only four lanes. Congestion occurs daily on this section. In addition, traffic operations are unsafe at the on- and off-ramps of the Salem Street/Lynn Street interchange, largely due to the ramps' geometric limitations, including the absence of deceleration and acceleration lanes, the tight turning radii, and the close proximity of adjacent ramps. The analysis reviewed add-a-lane options for relieving congestion on this section of Route 1, and looked at closing or redesigning the Salem Street/Lynn Street ramps to improve safety and traffic operations.

- **Truck connections -** The analysis responded to citizens' and local officials' complaints about truck traffic impacts in Everett, Chelsea, and East Boston. More direct and easier connections for trucks between Logan Airport, Route 1 north, and the industrial centers of Chelsea and Everett were investigated.

- **Traffic management** - The analysis investigated possible traffic management measures for Revere Beach Boulevard in Revere and Hancock Street in Everett. This analysis was a direct result of citizen complaints made at the public meetings about cut-through traffic and speeding vehicles and the resulting danger to pedestrians, bicyclists, and turning vehicles along these two roadways.

- **Congested signalized intersections** - Traffic operations at a number of congested intersections may be improved by signal retiming or by other modifications. The following intersections were selected for study:

  - Bennington Street @ Saratoga Street (intersection #95, East Boston)
  - Main Street @ Tileston Street/Oakes Street (#71, Everett)
  - Bennington Street/State Road @ Winthrop Avenue (#39, Revere)
  - Route 16 @ Winthrop Avenue/Harris Street (#84, Revere)
  - Route 1A @ Revere Street (#37, Revere)
  - Route 1A @ Beach Street (#87, Revere)
  - Route 60 @ Revere Street (#14, Revere)

  These seven locations were selected because they (1) had not been selected for improvement as part of another study and (2) are on major arterials and are significant to regional traffic flow.

- **Signal coordination along Route 16** - Travel time and delay runs on Route 16 in the study area revealed that traffic moved slowly on this major east-west facility during both the AM and PM peak periods. Moreover, eight of the nine signalized intersections studied along this corridor had an unacceptable level of service on one or more approaches. The analysis aimed to improve peak period traffic operations on side street approaches and along Route 16 by integrating signals into a coordinated system. The portion of Route 16 examined for signal coordination lies between Lewis Street in Everett and Webster Street/Garfield Street in Chelsea.

- **Pedestrian safety** - Pedestrian safety studies were conducted for four intersections identified from the accident analysis and from comments made at the public meetings:

  - Revere Beach Boulevard @ Oak Island Road (Revere)
  - Route 107 @ Central Avenue (Revere)
  - Route 99 @ Ferry Street (Everett)
  - Bennington Street @ Saratoga Street (East Boston)

- **Crowded parking lot at Wonderland Station** - The foundation for the analysis of the issue of crowding at the Wonderland Station parking lot was a license plate survey determining where the commuters parking there are originating. Strategically located satellite facilities would help alleviate parking pressures at the station, where parking presently overflows onto Revere Beach Parkway, and reduce traffic demands on Route 1, Route 60, Revere Street, and other roadways in between. The results of the license plate survey are summarized in Appendix F.

Searching for improvements that address these issues was the major effort of the Lower North Shore Transportation Improvement Study. The alternative improvements that were considered and the ones selected for recommendation are presented in the following chapters.

3 SHORT-RANGE ALTERNATIVES

The preceding chapter gave an overview of the issues identified through discussions with the Technical Advisory Committee (TAC) members and general public, and through the data collection/evaluation process. Section 2.5 lists issues/projects that are not included for study, design, or construction in the fiscal year 1999 Transportation Improvement Program (Table A-1 in Appendix A) or in any other program or mitigation plan. These issues became the focus of this study for investigating appropriate improvements. For issues such as traffic management, congested signalized intersections, signal coordination along Route 16, pedestrian safety, and crowded parking lot at Wonderland Station, this study developed improvements that can be implemented in the short term (within three years). For the rest of the issues, this study developed long-range improvements (more than three years for implementation).

All the short-range alternatives that were examined and their benefits are summarized in this chapter (for long-range alternatives, see Chapter 4). These alternatives are presented by issue type and by the alphabetical order of the study communities. For some of the issues a single improvement, such as a traffic signal retiming plan, geometric improvement, or change of operation, was proposed, while for others a set of alternative improvements were developed.

3.1 Hancock Street Traffic Management, Everett

Citizens at the Everett public meeting complained of frequent speeding on Hancock Street. The segment of Hancock Street that was addressed in this study runs east-west between Broadway in Everett and the Malden City Line, a distance of approximately 3,000 feet. It is 32.5 feet wide along its entire length; parking is permitted on the northbound side only. Land uses along Hancock Street are a mix of commercial and residential. A predominantly commercial zone exists on both sides of the street midway down the study segment, between Swan Street and Waverly Street.

There are four traffic signals along the segment, at the following locations (from west to east): a fully operational signal at Belmont Street at the Malden city line, a flashing signal at Tappan Street/Central Avenue, a fully operational signal at Walnut Street/Waverly Street, and a flashing signal at Broadway. The roadway is posted at 25 MPH.

The speeding is attributable to the roadway's high design speed, unintentionally engineered. The roadway is straight and has relatively few traffic control devices. Although the roadway is only 32.5 feet wide, parking being permitted on the north side of the street makes it appear wider. At the public meeting it was asserted that Malden residents frequently use this roadway and the one-way High Street to cut across Everett in the eastbound direction. Figure 3-1 shows the existing facilities and indicates some of the problems.

Three alternatives were developed for this segment of Hancock Street in Everett; they are described below. Each alternative builds upon the previous one; for example, the second alternative includes all the measures proposed in the first alternative, plus additional measures, and the third alternative includes all the measures proposed in the preceding two alternatives, plus additional measures. Table 3-1 presents the estimated construction costs for the alternatives.

Alternative 1

The main components of Alternative 1 and their benefits are summarized below:

- Provide contrasting crosswalks (for example, painted green)
  - Makes crosswalks more prominent
  - Reminds motorists to slow down
- Convert High Street from one-way eastbound to one-way westbound
  - Prevents cut-through traffic
  - Improves traffic flow on Broadway by eliminating interlocking left-turn queues formed by left-turns into Hancock Street and High Street
- Prohibit parking around Raymond MacKinnon Square; relocate parking to eastbound side of Gilmore Street
  - Improves recreational use of attractive open space
  - Clears space for fire trucks pulling in and out
- Give distinctive sidewalks in commercial area (for example, brick)
  - Encourages motorists to slow down by creating a "downtown" appearance

Figure 3-2 shows the locations of these suggestions.

Alternative 2

The main components of Alternative 2 and their benefits are summarized below:

- All of the Alternative 1 improvements (see above), plus:
- Alternate parking on northbound and southbound sides of Hancock Street
  - Discourages speeding by visually interrupting the continuity of the roadway
  - Maintains similar number of parking spaces
- Improve visibility of traffic signals
  - Encourages motorists to slow down and prepare to react
    - Option One: Relocate signal posts to bulb-outs
      - Bulb-outs shorten pedestrian crossing distances, provide protected parking bays, and slow vehicle speeds by narrowing the roadway
    - Option Two: Convert signal posts to overhanging
      - improves visibility of traffic signals at a lower cost than bulb-outs

Figure 3-3 shows the new measures proposed in this alternative. It should be noted that alternating parking on different sides of the street causes offset travel lanes. Transitional areas, formed by striping or modified curb design, help guide traffic.

Alternative 3

The main components of Alternative 3 and their benefits are summarized below:

- All of the Alternative 1 and Alternative 2 improvements (see above), plus:
- Narrow Hancock Street (expand sidewalk) through commercial area
  - Encourages slow speeds through the commercial area and on the approaches, at a minimum
  - Helps promote area businesses
- Convert the traffic signal at Belmont Street to a traffic circle
  - Discourages speeding upon entering Everett
  - Serves as gateway to welcome visitors to Everett

Figure 3-4 shows the new measures proposed in this alternative. It should be noted that the radius of the traffic circle should be designed wide enough to avoid "bypass" left turns. The conversion requires an expansion of the intersection in order to accommodate circulating traffic.

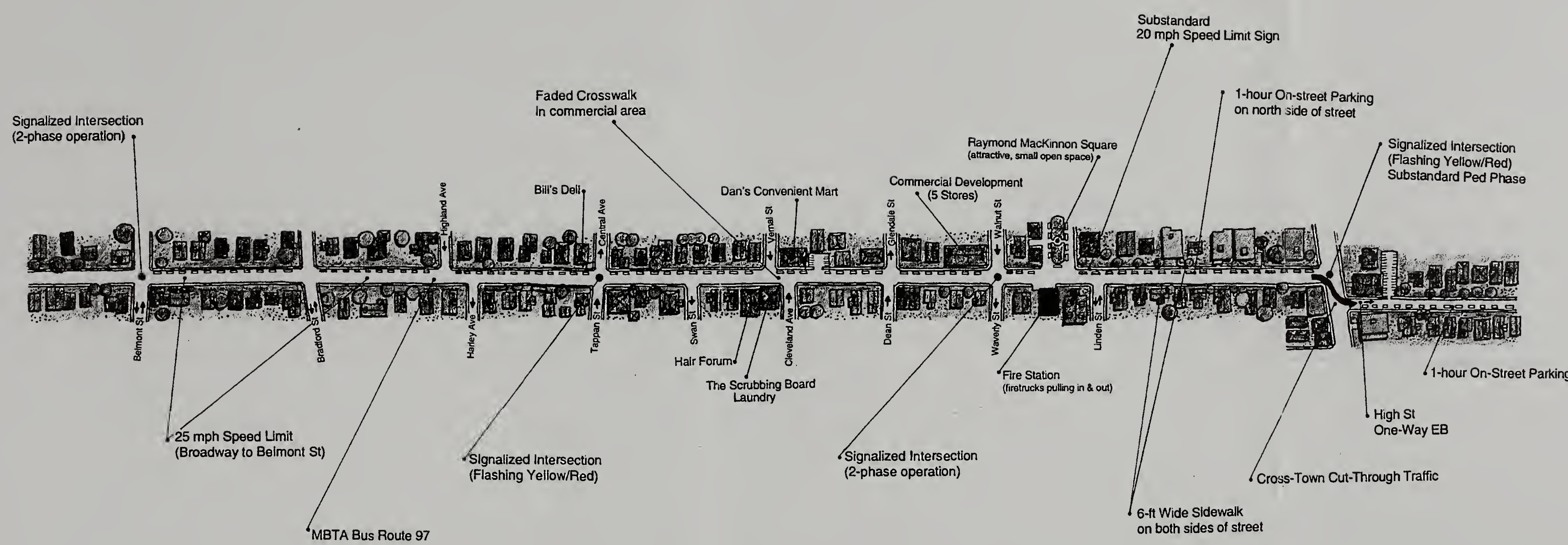


Figure 3-1
Existing Conditions
Hancock Street Traffic Management

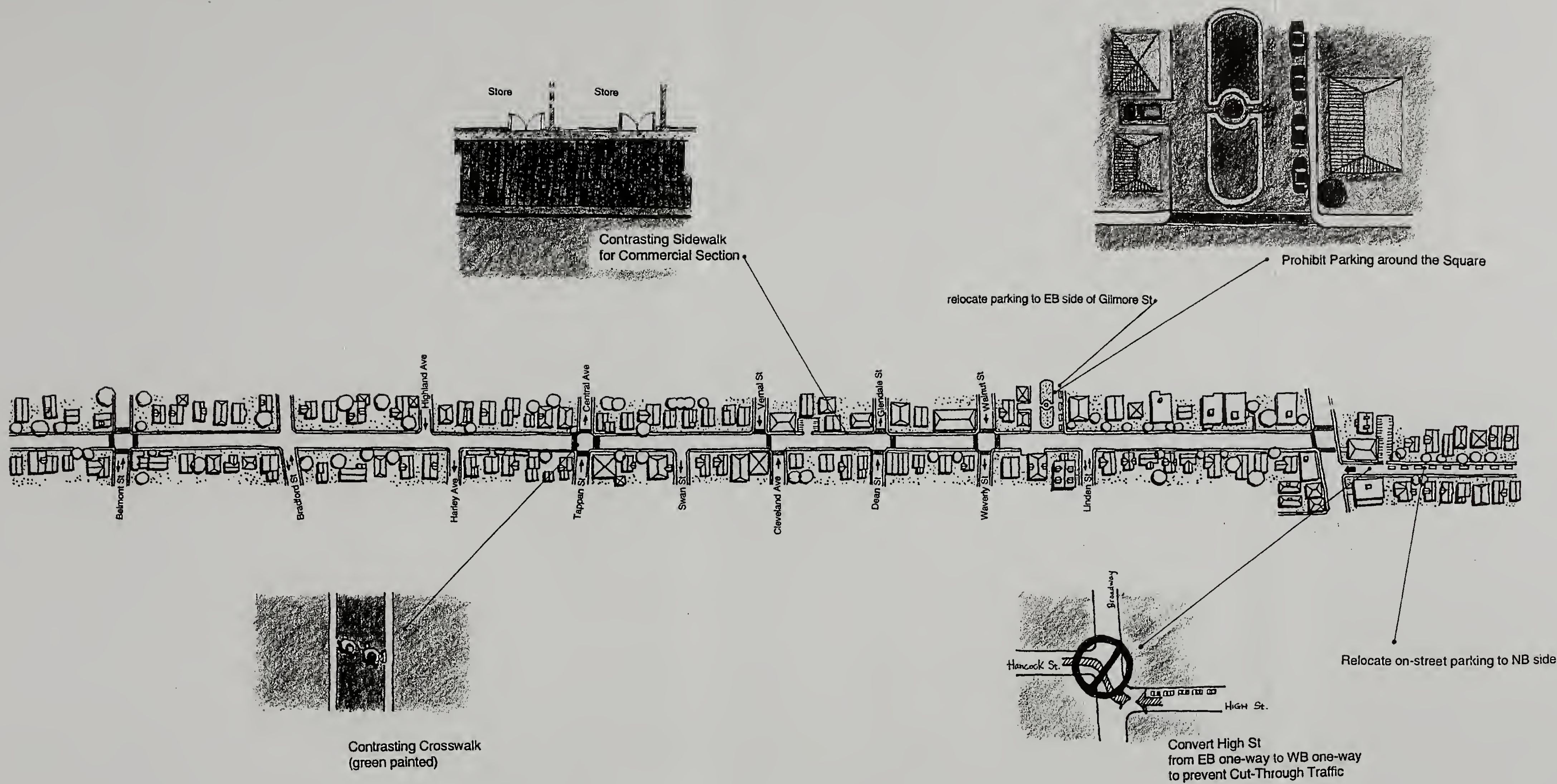
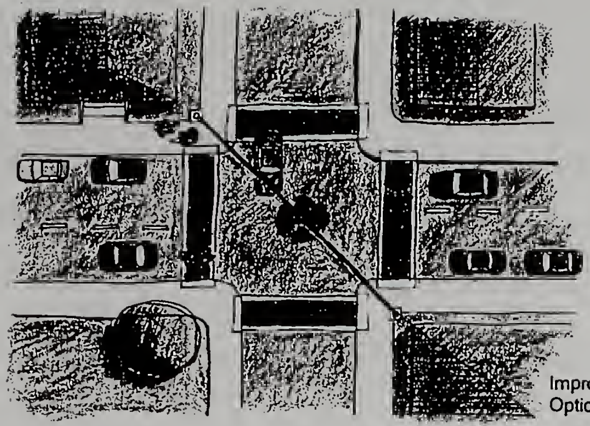
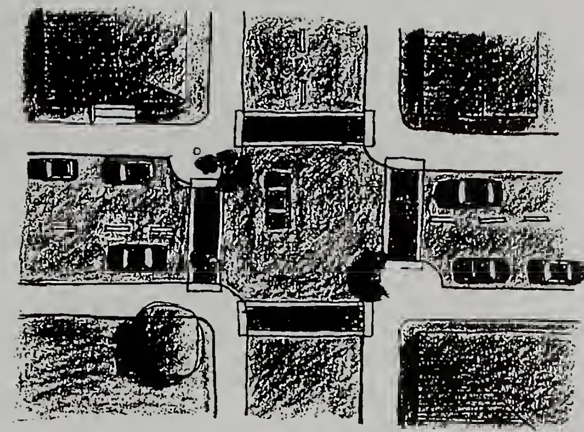


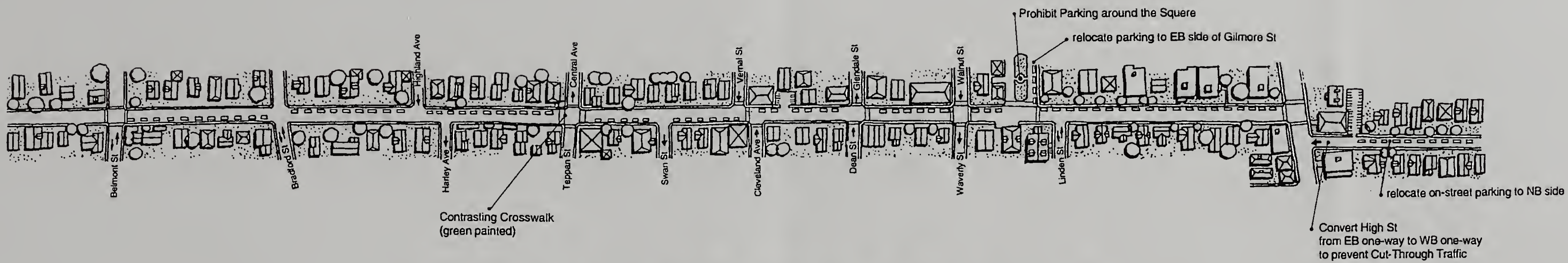
Figure 3-2
Alternative 1
Hancock Street Traffic Management

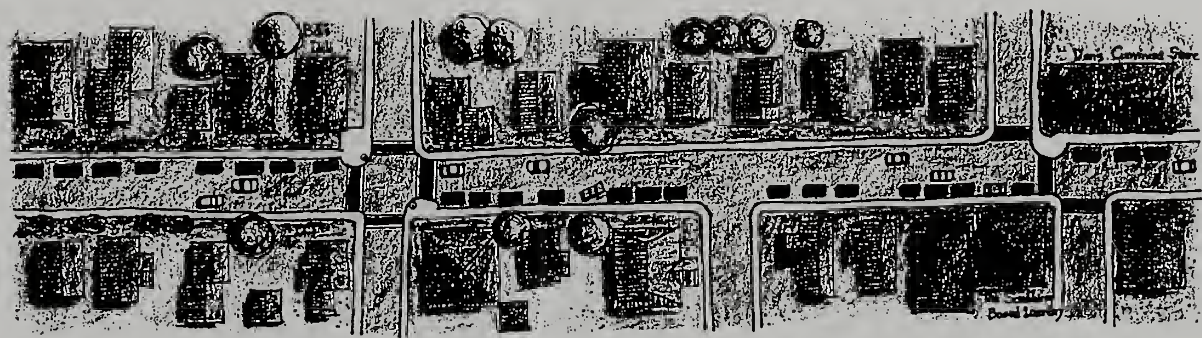


Improve Visibility of Traffic Signals
Option Two: Convert Signal Posts to Overhanging



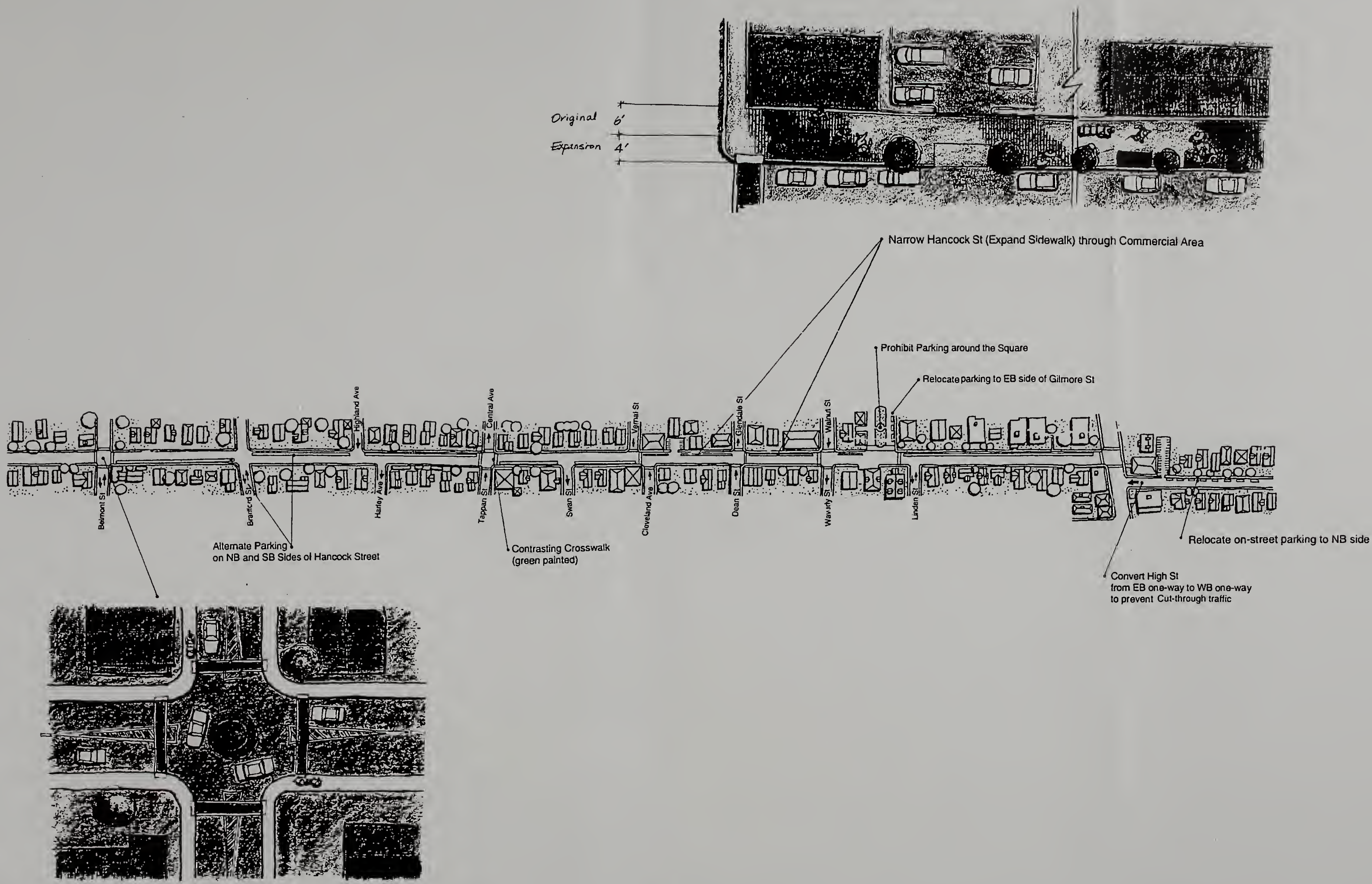
Improve Visibility of Traffic Signals
Option One: Relocate Signal Posts to Bulb-Outs





Alternate Parking
on NB and SB Sides of Hancock Street

Figure 3-3
Alternative 2
Hancock Street Traffic Management



Convert the Traffic Signal at Belmont St to a Traffic Circle (Concept Sketch)

Figure 3-4
Alternative 3
Hancock Street Traffic Management

Table 3-1
Construction Cost Estimate for Hancock Street Traffic Management

Construction Element/ Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Alternative One					
Upgrade Pedestrian Crosswalk	Crosswalk painted with contrasting green	Per installation	$250	24	$6,000
Upgrade Pedestrian Sidewalk	Replace concrete pavement with contrasting materials	Square foot	$10	6,000	$60,000
Parking Space Re-striping	Re-stripe parallel parking spaces on High St.	Space	$10	50	$500
				Subtotal: Alternative One	**$66,500**
Alternative Two					
Curb Extension (Bulb-Outs) for Pedestrian Staging	Extension of about 200 sq. ft. from sidewalk	Per installation	$3,000	8	$24,000
Upgrade Traffic Signal	Install New traffic signals at two intersections	Per installation	$75,000	2	$150,000
Parking Space Re-striping	Re-stripe parking spaces on Hancock St.	Space	$10	35	$350
				Subtotal: Alternative Two	**$174,350**
Alternative Three					
Sidewalk Expansion in Commercial Section	Expand sidewalk area of about 2,000 sq. ft.	Square foot	$10	2,000	$20,000
New Traffic Circle	Replace traffic signal with traffic circle	Per installation	$60,000	1	$60,000
				Subtotal: Alternative Three	**$80,000**
				Signage, pavement marking and landscaping (10%)	$32,085
				Traffic management during construction (10%)	$32,085
				Subtotal: Alternatives One ~ Three	**$385,020**
				Contingencies (15%)	$57,753
				Grand Total	**$442,773**

Notes:

Upgrade Pedestrian Crosswalk: Each installation covers a crosswalk area of about 200 sq. ft. (painted green) and two white crosswalk lines 8 inches wide and 35 feet long.
Upgrade Pedestrian Sidewalk: Replace concrete pavement with brick or other contrasting materials in the commercial section, covering an area of about 6000 sq. ft. (6'x500'x2).
Upgrade Traffic Signal: Install new overhanging signals with full pedestrian actuation at: 1)Hancock St. @ Walnut/Waverly Sts and 2) Hancock St. @ Central Ave./Tappan St.
New Traffic Circle: Replace traffic signal with traffic circle at the intersection of Hancock Street and Belmont Street.

Discussions with the Everett town engineer indicated that the intersection at Belmont Street is under the jurisdiction of Malden and its surrounding space is limited. If the traffic circle conversion is favored, a feasibility study should be conducted.

3.2 Revere Beach Boulevard Traffic Management, Revere

Complaints of vehicle speeding and "cruising" on Revere Beach Boulevard (RBB), and related concerns for pedestrian safety were voiced at the Revere public meeting. RBB runs north-south for approximately three miles. It is a recreational roadway with year-round activity, although usage increases substantially during the summer months. On the east side of the boulevard, land uses are strictly limited to the beach itself and associated amenities such as beach houses, rest areas, and parking (parallel and angle). On the west side, the boulevard is lined with single-family homes, apartment buildings, restaurants, and parallel parking.

South of Revere Street, RBB is the two-lane northbound component of a one-way pair. Ocean Avenue, located to the west of RBB, provides access for southbound traffic. RBB continues as a three-lane, two-way (one lane for southbound and two lanes for northbound) roadway to just south of Oak Island Street, where it narrows to a two-lane, two-way roadway. Lane widths are 12 feet. The speed limit of 30 MPH is frequently posted. No traffic signals are located along the roadway.

Pedestrian activity is high along and across RBB. Nearly 30 painted crosswalks are spread throughout the three miles. MBTA Bus Route 411 serves the corridor between Oak Island Street and Beach Street. Figure 3-5 shows the existing facilities and indicates some of the problems.

Proposed Improvements

The main components of the proposed improvements and their benefits are summarized below. Figure 3-6 shows the locations of the proposed improvements, and Table 3-2 summarizes the estimated construction costs.

- At all gateways, narrow roadway and install sign, "Entering Recreational Area: Drive Carefully"
  - Discourages speeding when entering RBB
  - Warns motorists that they are entering a special traffic management area
- Provide neckdowns at pedestrian crossing areas; make crosswalks more prominent; install "Cross Only at Crosswalk" signs
  - Helps motorists and pedestrians see one another better
  - Encourages pedestrians to cross at appropriate locations
  - Shortens pedestrian crossing distances
- Expand MBTA bus route(s) with stops located on RBB north of Oak Island Street
  - Provides transportation for the Point of Pines area and the boulevard residents
  - Potentially reduces traffic volumes along the corridor

CTPS developed improvements based on the needs identified in the TAC and public meetings. The city of Revere had expressed the need for continuing the beachside sidewalk north of Oak Island Street. The continuous beachside sidewalk is considered beneficial to the area and the city from both an urban design and a pedestrian safety standpoint, even if making room for the new sidewalk requires converting the angle parking to parallel parking and losing some parking spaces. The parking conversion also provides room for installing new bus stops along the boulevard. Residents on RBB and in the Point of Pines area had requested a bus route (for example, Route 441 or Route 442) with stops along upper RBB.

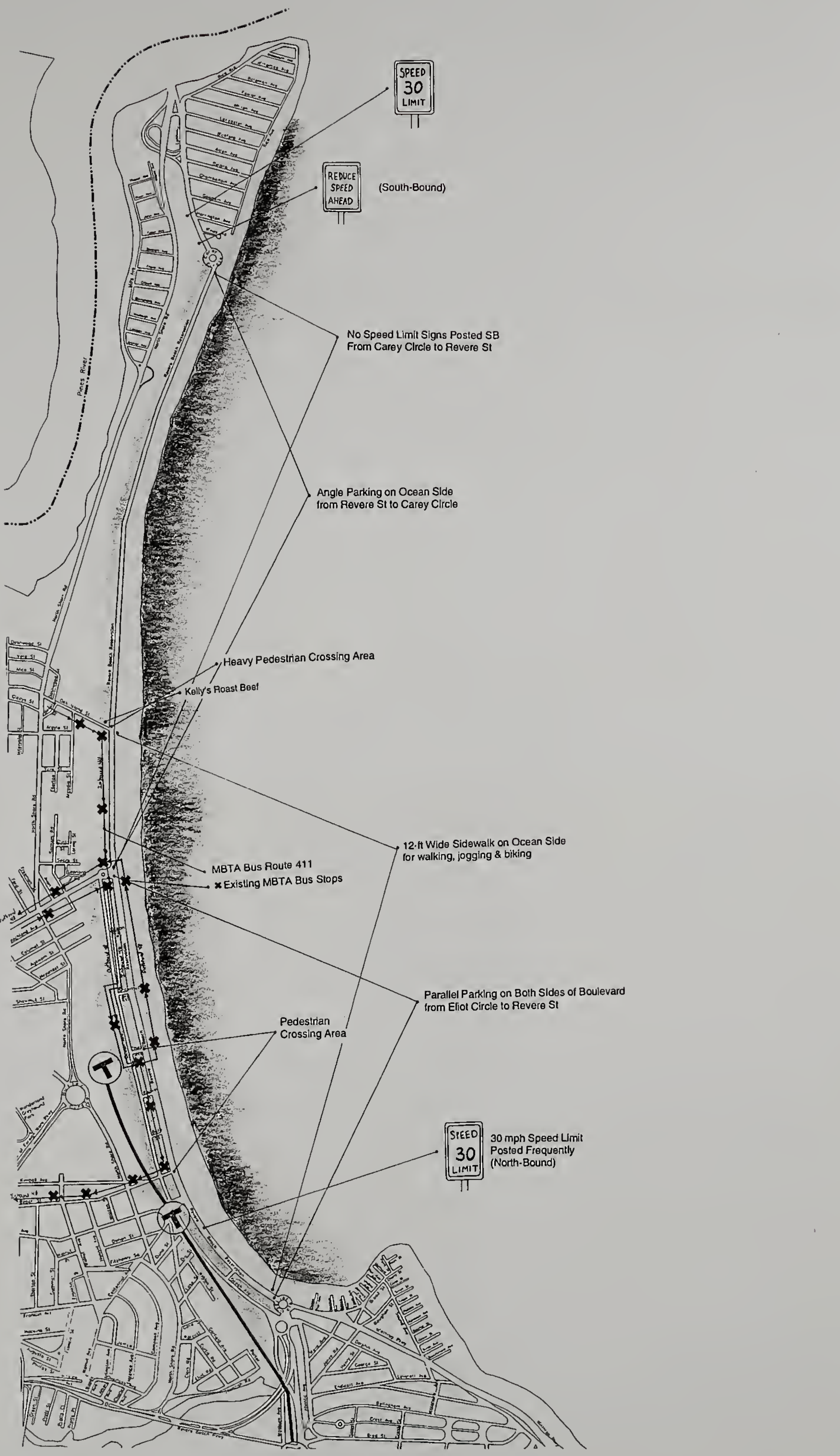


Figure 3-5
Existing Conditions
Revere Beach Boulevard Traffic Management

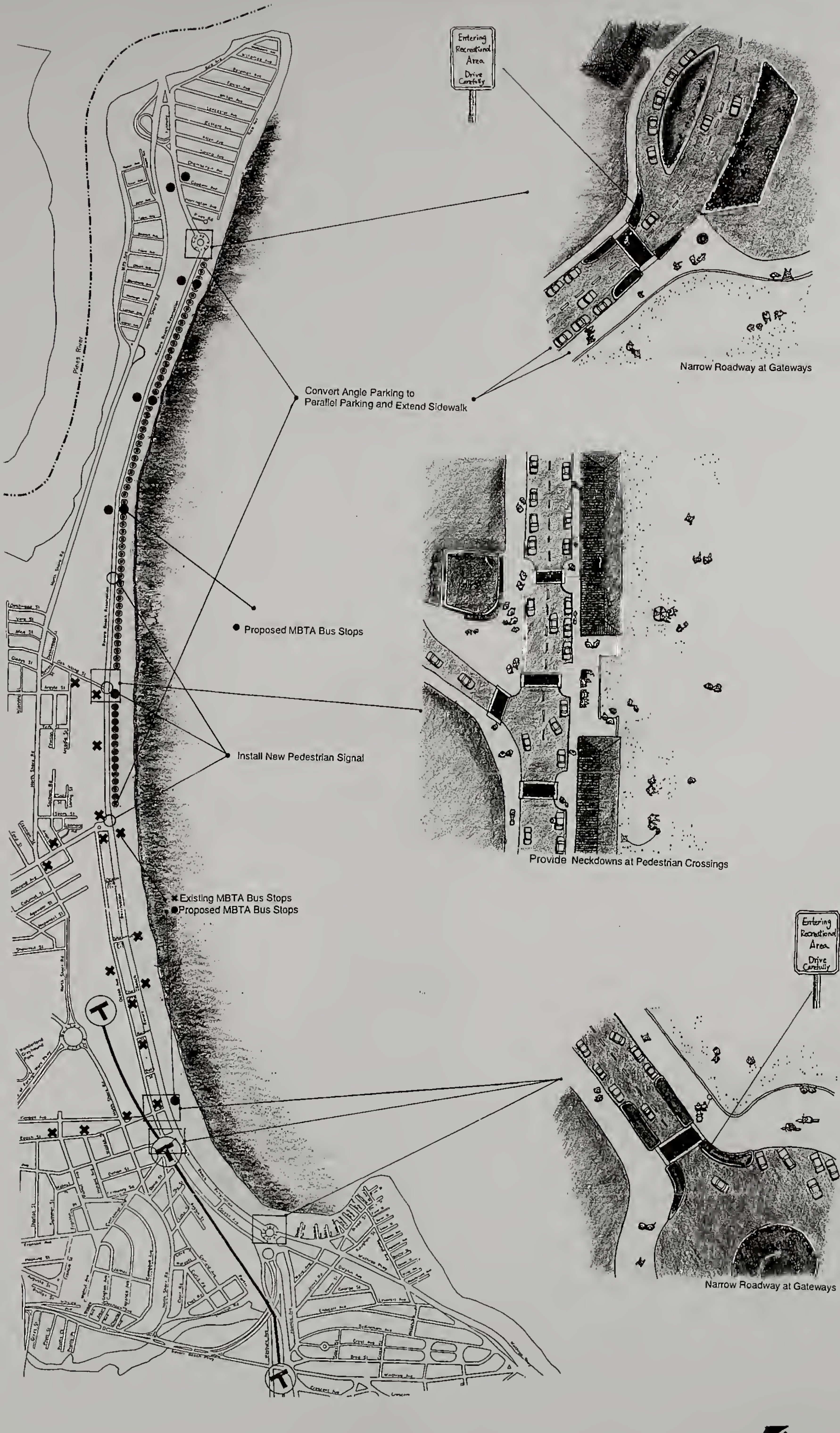


Figure 3-6
Proposed Improvements
Revere Beach Boulevard Traffic Management

Table 3-2
Construction Cost Estimate for Revere Beach Boulevard Traffic Management

Construction Element/ Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
New Sidewalk Installation	10 foot wide concrete sidewalk extending about 6,800 feet long	Square foot	$5	68,000	$340,000
Upgrade Pedestrian Cross-walk	Replace asphalt surface with contrasting materials	Per installation	$5,000	26	130,000
Curb Extension for Pedestrian Staging	Extension of about 400 square feet from sidewalk	Per installation	$6,000	20	120,000
Gateway Treatment for Boulevard Entrances	Curb extension, landscaping, and cross-walk upgrade	Per installation	$40,000	4	160,000
New Pedestrian Signal	Install six new pedestrian signals at three locations	Per installation	$50,000	6	300,000
Parking Space Re-striping	Re-stripe parallel parking spaces along Boulevard	Per space	$10	330	3,300
				Subtotal	**$1,053,300**
		Signage, pavement marking and landscaping (10%)			$105,330
		Traffic management during construction(10%)			$105,330
				Subtotal	**$1,263,960**
				Contingencies (15%)	$189,594
				Grand Total	**$1,453,554**

Notes:

New Sidewalk Installation: Total extension along the boulevard is estimated about 6,800 feet long. Assuming 10 feet wide, total area is about 68,000 square feet.
Upgrade Pedestrian Crosswalk: Assuming brick as the contrasting material and each installation covers about 500 square feet.
New Pedestrian Signals: Install six new pedestrian signals at three locations (two at each location):

1) Revere Beach Boulevard @ Oak Island Road (Kelly's Roast Beef),
2) about 250 feet north of Kelly's, at the crossing between the beach and an apartment complex, and
3) Revere Beach Boulevard @ Revere Street.

3.3 Congested Signalized Intersections

This section summarizes results from the optimization analyses conducted on isolated traffic signals in the study area. The intersections chosen for analyses were those defined as having a poor level of service (LOS) in the series of intersection traffic operation analyses (Table 2-1 and Appendix E). The operation of these signals is considered to be the prime reason for the intersections' poor LOS, since they are not near other signals which impact their operation. The following locations are included in this section:

- Bennington Street at Saratoga Street, East Boston
- Main Street at Tileston/Oakes Street, Everett
- Bennington Street/State Road at Winthrop Avenue, Revere
- Route 16 at Winthrop Avenue/Harris Street, Revere
- Route 1A at Revere Street, Revere
- Route 1A at Beach Street, Revere
- Route 60 at Revere Street, Revere

The program Highway Capacity Software (HCS) was used to analyze existing signal operating conditions. It is based on the analytical principles defined in the 1994 Highway Capacity Manual (HCM). The software chosen for signal optimization was SIG/Cinema version 1.11. This software was chosen for its ability to use HCM calculations accurately as well as its ability to test several types of phasing and cycle lengths using HCM delay calculations.

3.3.1 Bennington Street at Saratoga Street, East Boston

This intersection is the crossing of two major arterial roadways in East Boston and is most likely the busiest intersection in the community. This is also the location where Route 145 switches from Bennington Street onto Saratoga Street (in the northbound direction). The intersection is adjacent to several independent businesses and the Orient Heights rapid transit station; both of these circumstances generate large amounts of pedestrian traffic.

Bennington Street is a four-lane major arterial that travels generally in a north-south direction. It is a significant commuter route between downtown Boston/Logan Airport and northern communities such as Revere and Lynn. It also serves as an alternate arterial for Route 1A traffic. The westbound approach of Saratoga Street serves as the primary route for traffic exiting Winthrop, especially for traffic bound for Boston and Logan Airport. The eastbound approach of Saratoga Street is a single-lane approach, but it gets high volumes of traffic coming from the Central Square and Day Square areas of East Boston and Chelsea, and traffic diverting from Route 1A via Boardman Street to Bennington Street.

This intersection is highly congested during both the AM and PM peak hours. Figure 3-7 shows the existing layout and the summary of level of service (LOS) analyses. Although both peak hours have a poor LOS, the PM seems to have the most significant problems.

In this section, only the PM traffic condition will be discussed and examined. During the PM peak hour, three of the approaches are critical to the overall operation of the intersection: northbound Bennington, eastbound Saratoga, and westbound Saratoga. All of these movements must function well in order for the intersection to have an acceptable LOS.

Northbound Bennington has a two-lane approach; the right lane is an exclusive right-turn lane, while the left lane serves through and left-turning traffic. It should be noted that there is currently no exclusive left-turning phase in the signal timing and those left-turning vehicles

yielding to southbound traffic can seriously slow down the progression of northbound through vehicles. The right-turning volumes are also extremely high for a signalized intersection, serving vehicles heading for Winthrop. The right-turning volumes justify an exclusive right-turn lane, but having only one through lane that shares with left-turning traffic severely reduces the capacity of this approach.

Eastbound Saratoga's single lane serves all turning movements. It also has parking on both sides. The combined volumes exceed 400 vehicles during the PM peak hour, making it very hard to give this approach an acceptable amount of green time without harming the operations of the other approaches. This approach lacks the capacity needed to serve the current volumes.

Westbound Saratoga has a three-lane approach that currently operates at LOS B during the PM peak hour. The right lane serves right-turning traffic only. This lane provides a right-turn channelization to allow vehicles to yield onto northbound Bennington Street. It serves only 105 vehicles during the PM peak hour. The left lane is an exclusive left-turning lane. The center lane is a shared through and left lane. The left-turning volumes are the highest volumes on this approach during the AM peak hour and warrant two lanes for that movement. During the PM peak hour, the left-turning volumes and through volumes are about equal. This approach provides a 34-second exclusive phase for left-turning traffic, followed by a 40-second permissive phase shared with the eastbound approach. This operation provides a large amount of green time to achieve LOS B; however, it creates a dangerous situation. The existence of the exclusive and shared left-turn lanes warrants that the left-turn movement should be a protected-only phase. The current permissive phase of eastbound and westbound is an operational safety concern and should likely be eliminated. Instead, the eastbound and westbound phases should be split.

With the high volumes on the northbound, eastbound, and southbound approaches, a simple phase or timing change will not improve the operation of the intersection. Two alternatives, both requiring some change in geometry or operations, were developed for this location: (1) channelization improvements along with equipment upgrades, and (2) traffic diversions accomplished shifting traffic patterns. The analysis of existing conditions also shows some insufficient crossing times for pedestrians, as the right-turn-on-red phase on some approaches conflicts with the pedestrian phase. The pedestrian crossing issue at this location was further examined in Section 3.5, Pedestrian Safety Improvement.

Alternative 1 – Channelization Improvements, with Signal Equipment Upgrades

Figure 3-8 shows channelization improvements that would retain all existing turning movements and would provide an acceptable LOS. No widening of the roadway seems to be required.

This alternative calls for removing the traffic island on the westbound approach on Saratoga Street and reducing the approach to two lanes: one left-turning lane and one right lane for all movements. The lane taken away from the westbound approach is given to the eastbound departure for a total of two lanes.

On the eastbound approach on Saratoga Street, parallel parking on the left side of the roadway is eliminated. The roadway is restriped as two lanes. The left lane is a through-left shared lane. The right lane is a through-right shared lane. The added capacity on the eastbound approach and departure is needed for the PM eastbound traffic volumes.

The northbound and southbound approaches on Bennington Street require the removal of parking on each approach and departure for a minimum of 600 feet from the intersection to allow the addition of an exclusive left-turn lane for both directions and an exclusive right-turn for the

northbound direction. The addition of the exclusive left-turn lanes permits storage for turning vehicles, preventing them from impeding through movements. It also allows two through lanes for each direction, which should adequately handle the traffic volumes during each peak hour. The exclusive right-turning lane must remain to account for the 500+ vehicles turning onto Saratoga Street during the PM peak hour.

All signal equipment should be upgraded to meet current standards.

Alternative 2 – Shift Traffic Patterns, Including Signal Equipment Upgrades

Alternative 1 consists of channelization improvements which would add through lanes and turning lanes on various approaches to improve the LOS of the intersection. Although those improvements would be require fairly inexpensive to implement, the alternative does require the elimination of most of the on-street parking near the intersection. Elimination of parking could negatively affect the businesses located at this intersection, and the proposal could encounter local opposition.

Alternative 2 addresses this concern by allowing all existing on-street parking to remain and still improves the LOS of the intersection. The main problem at this intersection is that there are too many vehicles from all approaches to allow an overall acceptable timing scheme. The idea is to move one of the approaches to another location, which would presumably allow the intersection to operate at a better LOS. The eastbound Saratoga Street approach seemed to be the most viable option for diversion, because diverting Bennington Street traffic would put too much volume on side streets, and westbound Saratoga Street traffic must be able to use the newly constructed bridge over the MBTA Blue Line.

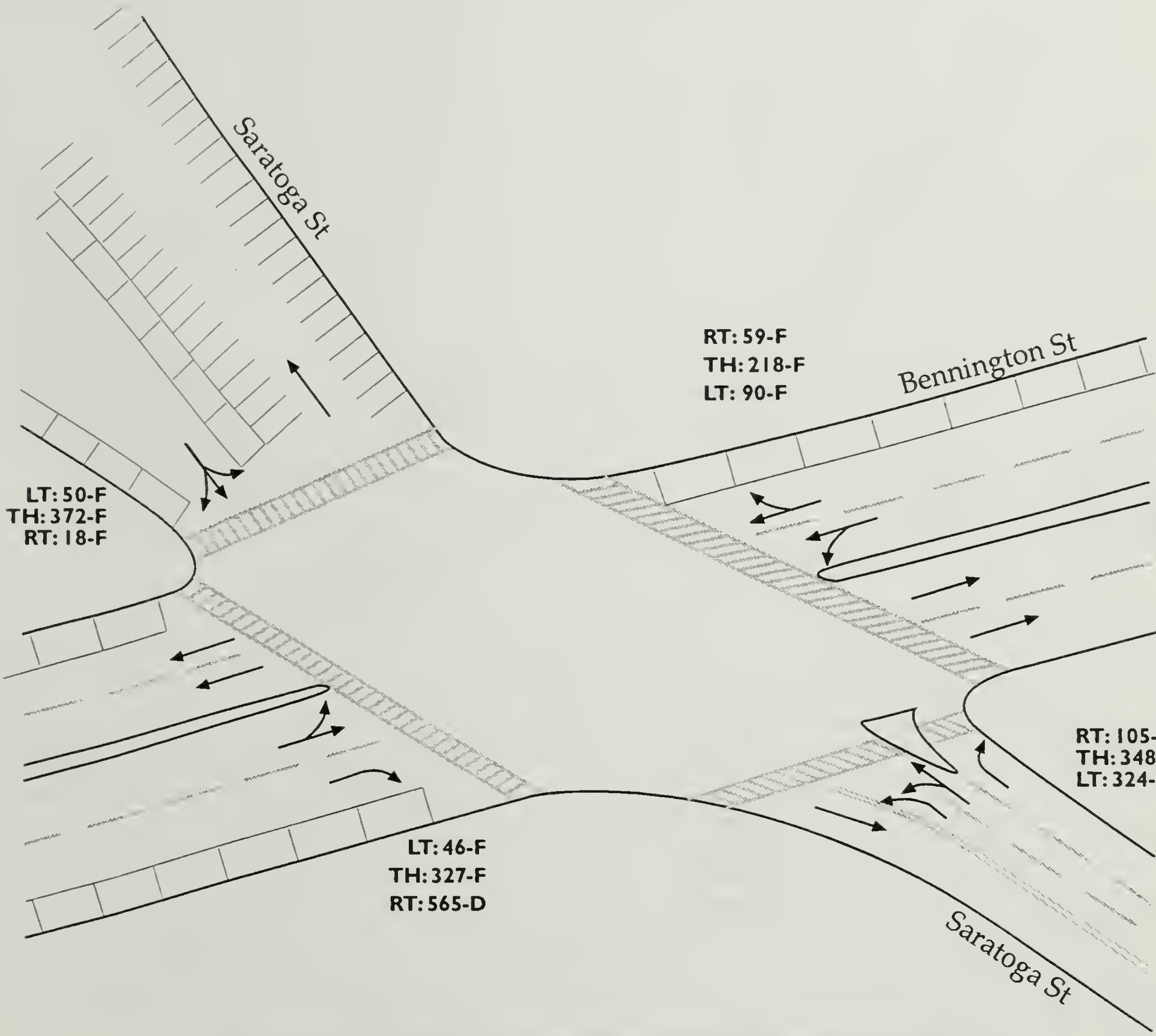
Alternative 2 proposes that eastbound Saratoga Street be relocated to the intersection of Trident Street and Bennington Street. Saratoga Street would become one-way, westbound (inbound) between Bennington Street and Trident Street. Beyond Trident Street, Saratoga Street would revert to two-way, as it currently is. Trident Street would also become a one-way street in the "westerly"-bound direction between Saratoga Street and Bennington Street. A traffic signal would be installed at the intersection of Trident Street and Bennington Street. Figures 3-9 and 3-10 show the proposed changes and estimated level of service at the two intersections.

Vehicles traveling westbound on Saratoga coming from Winthrop can still access southbound Bennington, westbound Saratoga (inbound), and Boardman Street. Northbound and southbound Bennington Street traffic can also access both directions of Saratoga Street and Boardman Street. Vehicles traveling on eastbound (outbound) Saratoga Street must divert to Trident Street and over to Bennington Street to continue outbound. Vehicles traveling on Boardman Street toward Winthrop must divert onto westbound Saratoga Street (inbound) at the intersection of Saratoga Street and Boardman Street and go to Trident Street. Then, they must go to northbound Bennington Street to continue north or to access eastbound Saratoga to get to Winthrop.

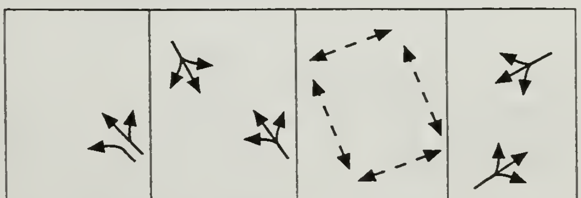
Boardman Street traffic traveling eastbound from Route 1A to Bennington Street is the traffic that would be the most inconvenienced by Alternative 2. However, that inconvenience might be considered by East Boston residents to be desirable, since it might bring a reduction in the amount of afternoon traffic using this route and lower traffic volumes on their local streets.

If this alternative is received favorably by the city of Boston and by East Boston residents, pursuing it would require more traffic counts in the area and further study to determine for certain that other neighborhood streets would not be adversely affected.

Figure 3–7
Existing Geometry, PM Traffic Volumes and Signal Phase Plan
Bennington Street @ Saratoga Street, East Boston



Signal Phase Plan for PM Peak Hour



G: 34 Y: 6	G: 40 Y: 5	P: 6.3	G: 32 Y: 6

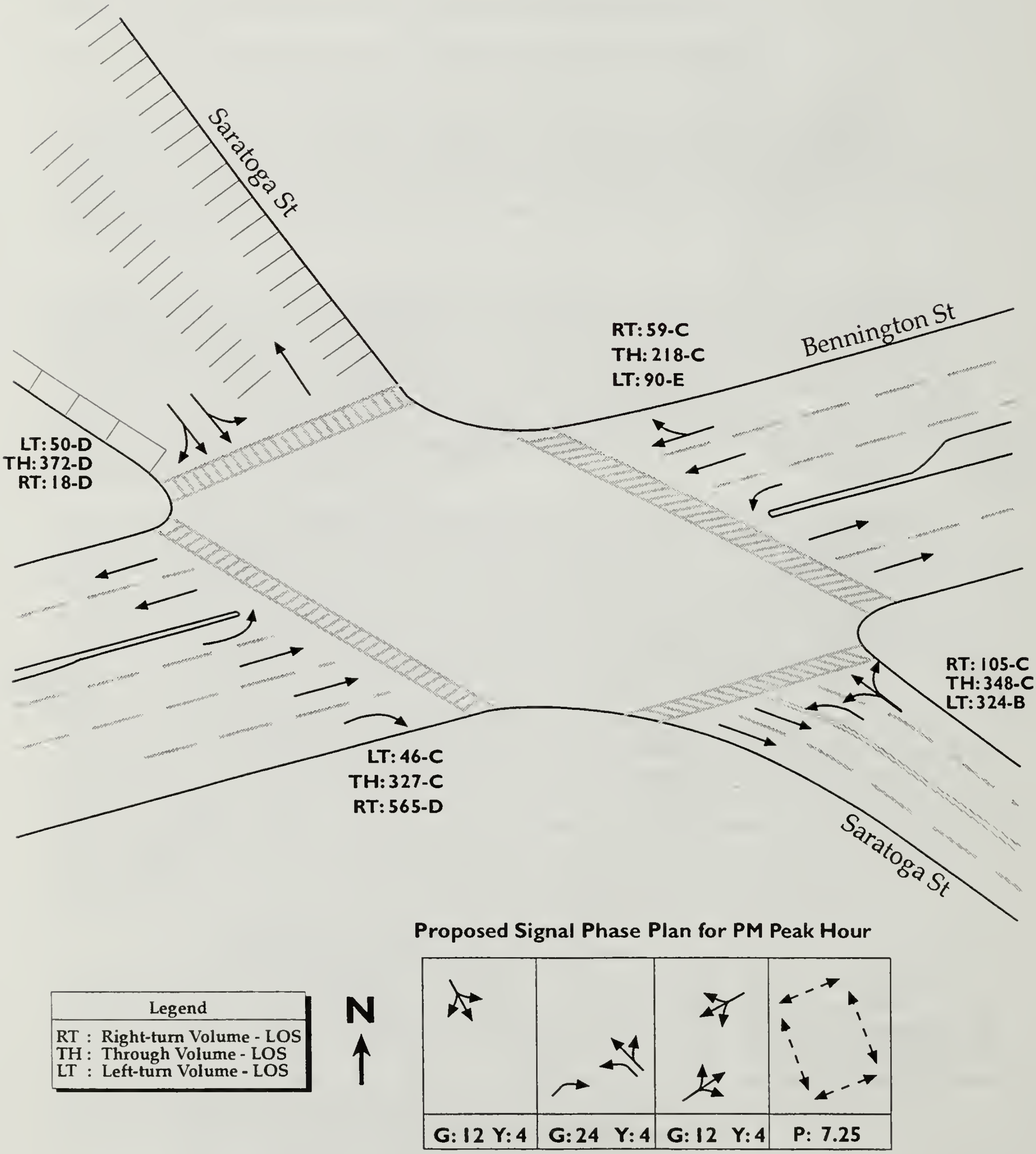
G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

Legend

RT : Right-turn Volume - LOS
TH : Through Volume - LOS
LT : Left-turn Volume - LOS

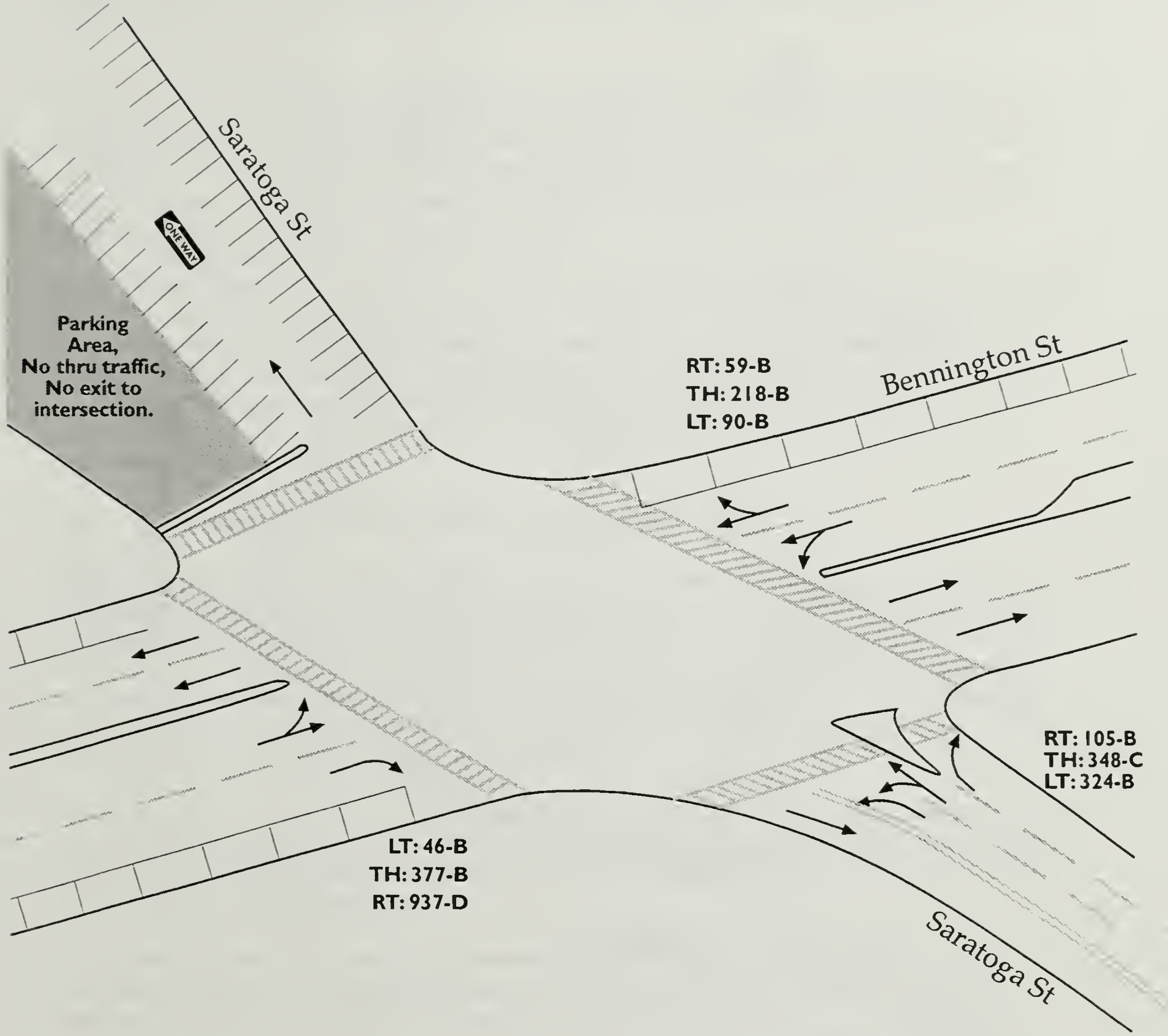
N

Figure 3–8
Proposed Geometric Improvements and Signal Phase Plan
Alternative 1
Bennington Street @ Saratoga Street, East Boston

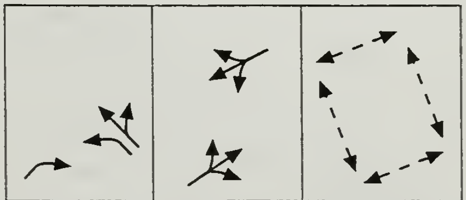


G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

Figure 3–9
Proposed One-Way Operation on Saratoga Street and Signal Phase Plan
Alternative 2 (first of two figures)
Bennington Street @ Saratoga Street, East Boston



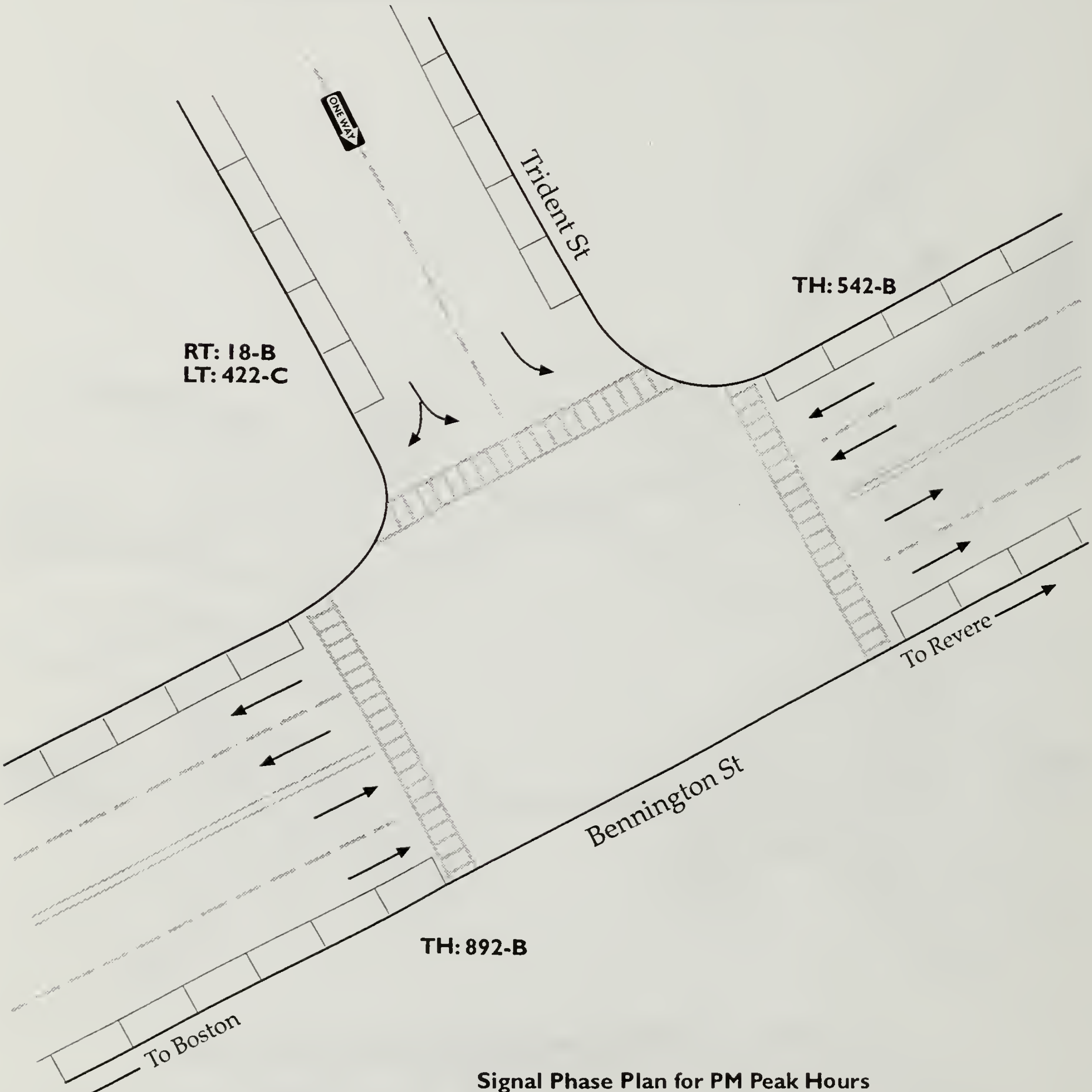
Proposed Signal Phase Plan for PM Peak Hour



G: 24 Y: 4	G: 28 Y: 4	P: 7.25

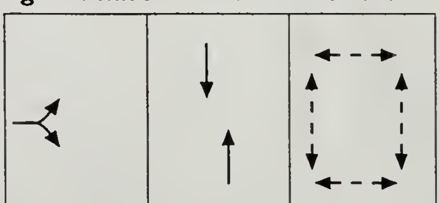
G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

Figure 3–10
Proposed One-Way Operation on Trident Street and Signal Phase Plan
Alternative 2 (second of two figures)
Bennington Street @ Saratoga Street, East Boston



Legend
RT : Right-turn Volume - LOS
TH : Through Volume - LOS
LT : Left-turn Volume - LOS

Signal Phase Plan for PM Peak Hours



G: 18 Y: 4	G: 34 Y: 4	P: 7.25

G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

3.3.2 Main Street at Tileston/Oakes Street, Everett

This intersection is located just north of Sweester Circle (the interchange of Route 16 and Route 99 in Everett). The intersection capacity and optimization analyses indicate that the operation of this intersection can be improved to an acceptable LOS by simply adjusting the signal phases and timing. Figure 3-11 shows the existing conditions and Figure 3-12 shows the proposed signal phasing and timing plan. Volumes, LOS, and timings are shown in the two figures for both AM and PM peak hours.

The intersection currently has an old signal system that needs to be upgraded to meet the current standards. It is also suggested that the exclusive "all-walk" pedestrian phase be eliminated and that pedestrians cross concurrently with parallel vehicular traffic. The green time of the exclusive pedestrian phase then can be shifted to Main Street approaches to reduce intersection congestion. A warning sign of pedestrian crossings should be installed on all right-turning approaches to remind motorists to yield to crossing pedestrians.

If completely eliminating the "all-walk" phase is not favored, an actuated "all-walk" phase can be installed with the new signal system. In that case, a number of on-street parking spaces on Main Street may need to be reduced in order to improve the intersection's operation. However, the Everett city engineer indicated that removing some of the on-street parking spaces is an option not likely to be supported by the neighborhood. The intersection is one of those for which the developers of the Gateway Shopping Center project on Route 16 Santilli Circle have agreed to provide mitigation.

3.3.3 Bennington Street/State Road at Winthrop Avenue, Revere

This is a busy intersection with only three entering approaches. It has high pedestrian volumes due to the adjacent Beachmont rapid transit station. Bennington Street is a three-lane roadway that leads to and from East Boston. State Road is a three-lane roadway that leads to and from Revere Beach. Winthrop Avenue is a two-lane roadway on the western side of the intersection and a single-lane one-way street leaving the intersection on the east side. It is a minor arterial that connects the Beachmont residential area to Revere Beach Parkway. Figure 3-13 shows the existing layout and traffic volumes of the intersection.

The intersection is congested during both peak hours. However, the PM peak hour has the most significant problems and will be discussed here. Developing a signal phasing and timing scheme and channelization upgrades that will bring about an acceptable LOS for the PM peak hour will do the same for the AM peak hour.

During the PM peak hour, two of the movements are critical to the overall operation of the intersection: the left-turn movement from northbound Bennington to westbound and the eastbound approach on Winthrop Avenue.

Northbound Bennington Street is a two-lane approach with a shared left-through lane and a shared right-through lane. There is only one departure lane on the State Road side (north side) of the intersection; it has curb parking. Northbound Bennington has a very high number of through and left-turning vehicles during the PM peak hour (700+ vehicles per hour). Over 50% of those vehicles are turning left. The approach is provided with a 17-second protected phase for left turns, but this is not enough to adequately handle the volumes. When the southbound traffic is released and the left turns become permissive for both directions, the intersection operates in a state of chaos as turning vehicles look for gaps and cut off opposing through traffic. The leading left-turn protected phase is warranted, but for the safety of both motorists and pedestrians, it

would be advisable to "split" the northbound and southbound phases due to the high percentages of left-turning vehicles in each direction.

Eastbound Winthrop Avenue is a single-lane approach that carries over 500 vehicles during the PM peak hour. Although there are no opposing movements during its green phase, the high number of vehicles using the approach with only one lane makes it impossible to extend green time to an acceptable LOS without negatively affecting other approaches.

Proposed Improvements

Figure 3-14 shows the channelization and signal phasing proposed for improving the operations and safety of the intersection.

Since the Bennington approach already has two lanes and provides a protected left-turn phase, there do not seem to be any potential improvements for this approach other than measures that could affect adjacent businesses. It was decided to focus on improving the eastbound Winthrop approach. Winthrop Avenue measures 32 feet in width at its narrowest point between the Bennington/State Road intersection and the Washburn Avenue intersection. This enables it to have three 10-foot lanes. Adding a designated right-turn lane would improve the LOS for the approach. An exclusive right-turn lane was chosen because the right-turning volume is high and the left-turn movement does not have opposing traffic from Winthrop Avenue.

It is also suggested that the northbound and southbound approaches on Bennington Street/State Road be split. With the large number of left turns on each approach, this should result in a safer operation for motorists and pedestrians. Additionally, the left lane on the northbound approach should be restriped as an exclusive left-turn lane and the right lane remain as a shared through-right lane, since there is only one departure lane on the north side. Finally, it is recommended that "No Turn on Red" signs be installed on every corner, to make crossings by pedestrians safer during the actuated "all-walk" phase.

3.3.4 Route 16 at Winthrop Avenue/Harris Street, Revere

The intersection capacity and optimization analyses indicate that the operation of this intersection can be improved to an acceptable LOS by adjusting the signal phasing and timing. Figure 3-15 shows the existing conditions and Figure 3-16 shows the proposed signal phasing and timing plan. Volumes, LOS, and timings are shown in the two figures for both the AM and PM peak hours. It is suggested that the cycle length be reduced from 158 seconds, which leads to unnecessary delays on all approaches, to 90 seconds. It is also suggested that green time be relocated from the Route 16 approaches to the Winthrop Avenue northbound approach which has the heaviest traffic of all the approaches. These changes can improved the intersection LOS from E-F range to D during both the AM and PM peak periods.

3.3.5 Route 1A at Revere Street, Revere

This intersection is located near Wonderland Station, and a large portion of the vehicles traversing it during the AM and PM peak hours are those of park-and-ride commuters. The intersection capacity and optimization analyses indicate that the operation of this intersection can be improved to an acceptable LOS by adjusting the signal phasing and timing. Figure 3-17 shows the existing conditions and Figure 3-18 shows the proposed signal phasing and timing plan.

There are currently both exclusive left-turn phases and leading green phases. It is suggested that the exclusive left-turn phases be removed, with the leading green on Revere Street retained for all

time periods, along with a leading green southbound in the AM peak period and northbound in the PM peak period.

The Revere city planner raised the concern that removing the exclusive left-turn phases on Route 1A could lead to unsafe conditions with left-turning vehicles struggling for gaps on the busy roadway. It is suggested that operations be monitored to ensure that these left-turns are made safely.

3.3.6 Route 1A at Beach Street, Revere

This intersection is located approximately 200 feet north of Mahoney Circle. The intersection capacity and optimization analyses indicate that the operation of this intersection can be improved to an acceptable LOS by adjusting the signal phasing and timing. Figure 2-19 shows the existing conditions and Figure 3-20 shows the proposed signal phasing and timing plan. The intersection is currently under a two-phase operation with a cycle length of about 100 seconds. It is suggested that the cycle length be reduced to 60 seconds, that the yellow and all-red time be reduced from 6 seconds to 4 seconds for all phases, and that some portion of green time be shifted from Route 1A to Beach Street. Observations at this intersection indicated that traffic on southbound Route 1A frequently backs up from Mahoney Circle during the AM peak period. Presumably this condition will not occur as frequently once the Mahoney Circle project is completed.

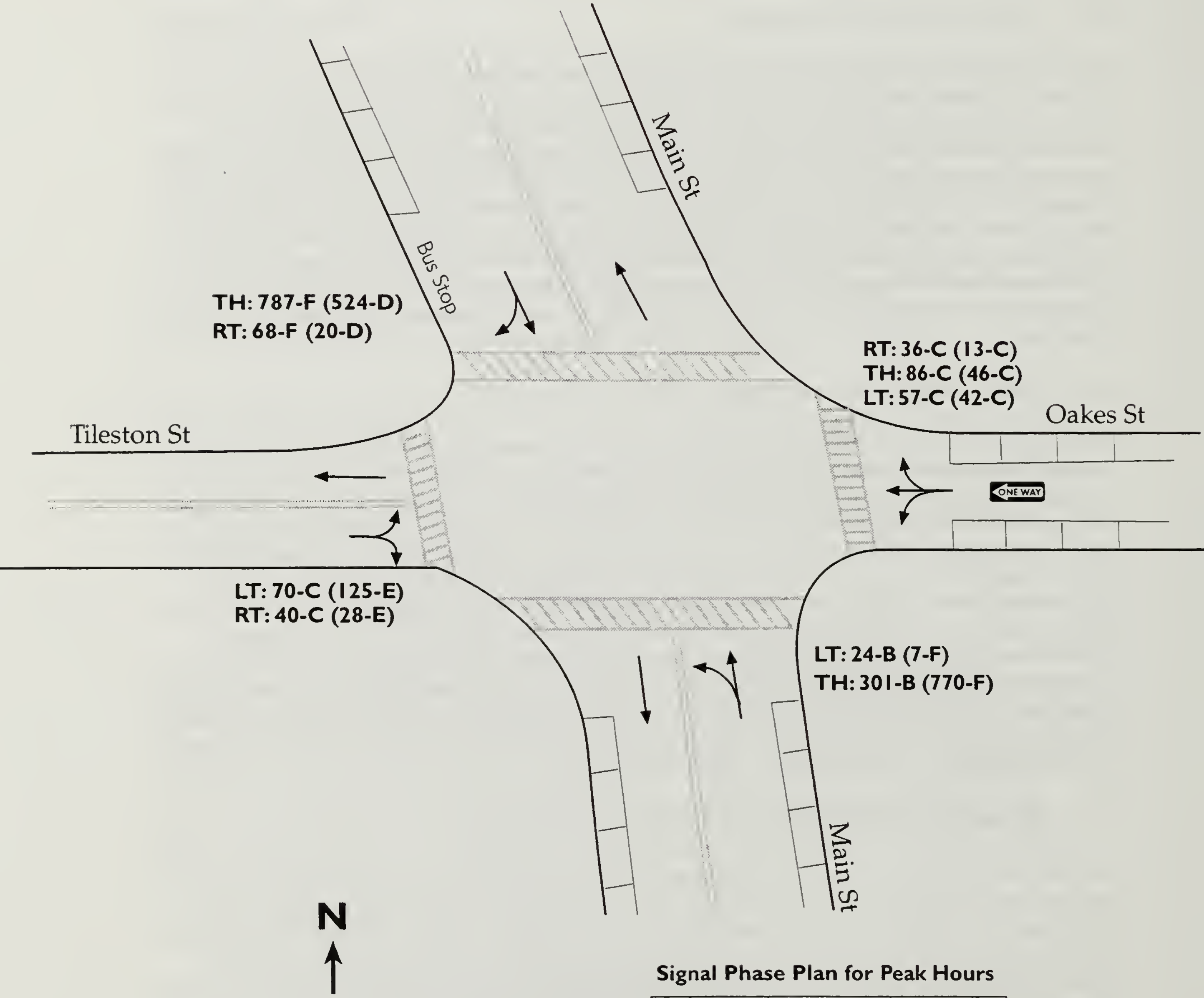
3.3.7 Route 60 at Revere Street, Revere

This intersection is located south of Brown Circle. The city has received many complaints about the severity of delays on almost every approach of the intersection. The intersection capacity analysis did indicate that the traffic volumes on all approaches are above capacity and that signal timing adjustments alone cannot solve the existing problems. Figure 3-21 shows the existing traffic volumes and LOS for each approach. Extensive delay was estimated for the southbound left-turn approach; the majority of this movement's volume is cut-through traffic destined for Wonderland Station or Route 1A. As traffic demand greatly exceeds supply at this location, the only options are to add more lanes or to divert traffic to another travel path. Traffic volumes have increased extensively since Hutchinson Street, a shortcut to Revere Street, was closed to southbound left turns from Route 60 due to their impact on the surrounding neighborhood. The project of grade-separating Mahoney Circle is expected to alter traffic patterns in such a way that the traffic at this intersection might be improved to an acceptable level. For now, no new signal phasing or timing plans are proposed for this intersection.

3.4 Revere Beach Parkway (Route 16) Signal Coordination

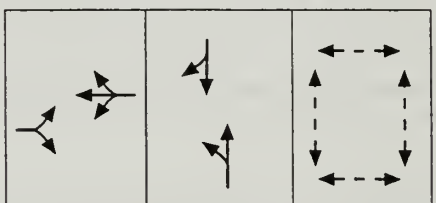
Revere Beach Parkway is currently one of the most congested arterials in the study area. Besides the large amount of traffic that uses the arterial every day, the many signals motorists encounter on Revere Beach Parkway in Everett and Chelsea create an added delay. The congestion would be reduced through the coordination of the traffic signals between Lewis Street in Everett and Webster/Garfield Street in Chelsea. Coordinating the traffic signals creates a "green-wave" effect, which keeps traffic in groups or platoons. As these platoons are released at the first signal between Lewis Street and Garfield/Webster Street, the next traffic signal they encounter will turn green right before the platoon reaches it. This allows vehicles to pass through every signalized intersection with little delay.

Figure 3–11
Existing Geometry, Traffic Volumes and Signal Phase Plan
Main Street @ TilestonStreet/Oakes Street, Everett



Legend
RT : AM Right-turn Volume - LOS (PM Volume - LOS) TH : AM Through Volume - LOS (PM Volume - LOS) LT : AM Left-turn Volume - LOS (PM Volume - LOS)

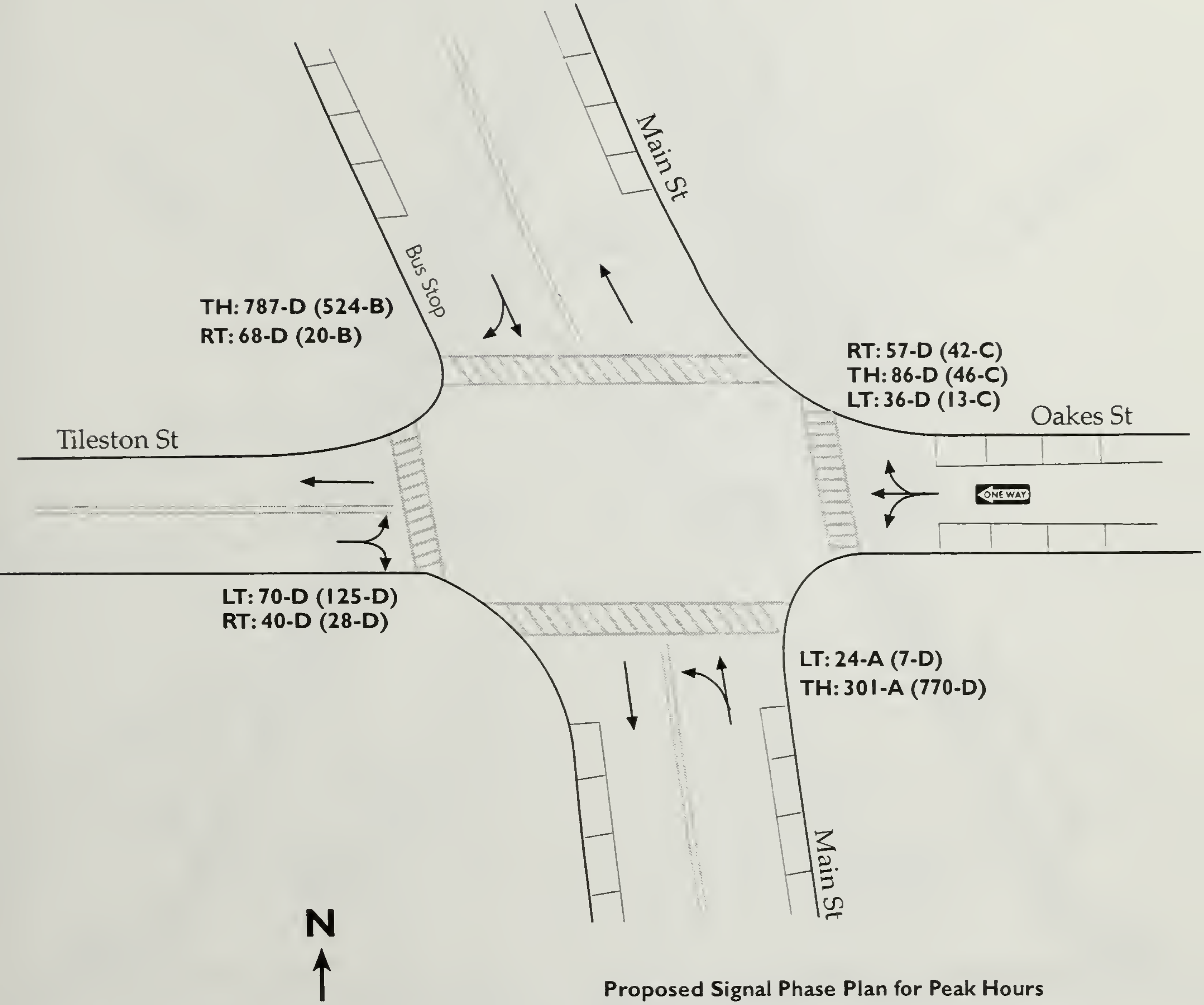
Signal Phase Plan for Peak Hours



AM	G: 14 Y: 4	G: 34 Y: 3	P: 11
PM	G: 14 Y: 4	G: 35 Y: 3	P: 11

G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

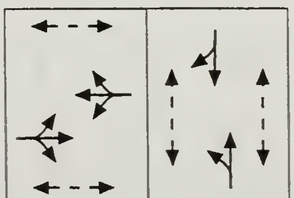
Figure 3–12
Proposed Signal Phase Plan and Estimated Levels of Service
Main Street @ Tileston Street/Oakes Street, Everett



Legend

RT : AM Right-turn Volume - LOS (PM Volume - LOS)
TH : AM Through Volume - LOS (PM Volume - LOS)
LT : AM Left-turn Volume - LOS (PM Volume - LOS)

Proposed Signal Phase Plan for Peak Hours



AM	G: 16 Y: 4	G: 56 Y: 3
PM	G: 20 Y: 4	G: 52 Y: 3

G = Green Time (sec)
Y = Yellow = All-Red (sec)

Figure 3–13
Existing Geometry, PM Traffic Volumes and Signal Phase Plan
Bennington Street/State Road @ Winthrop Avenue, Revere

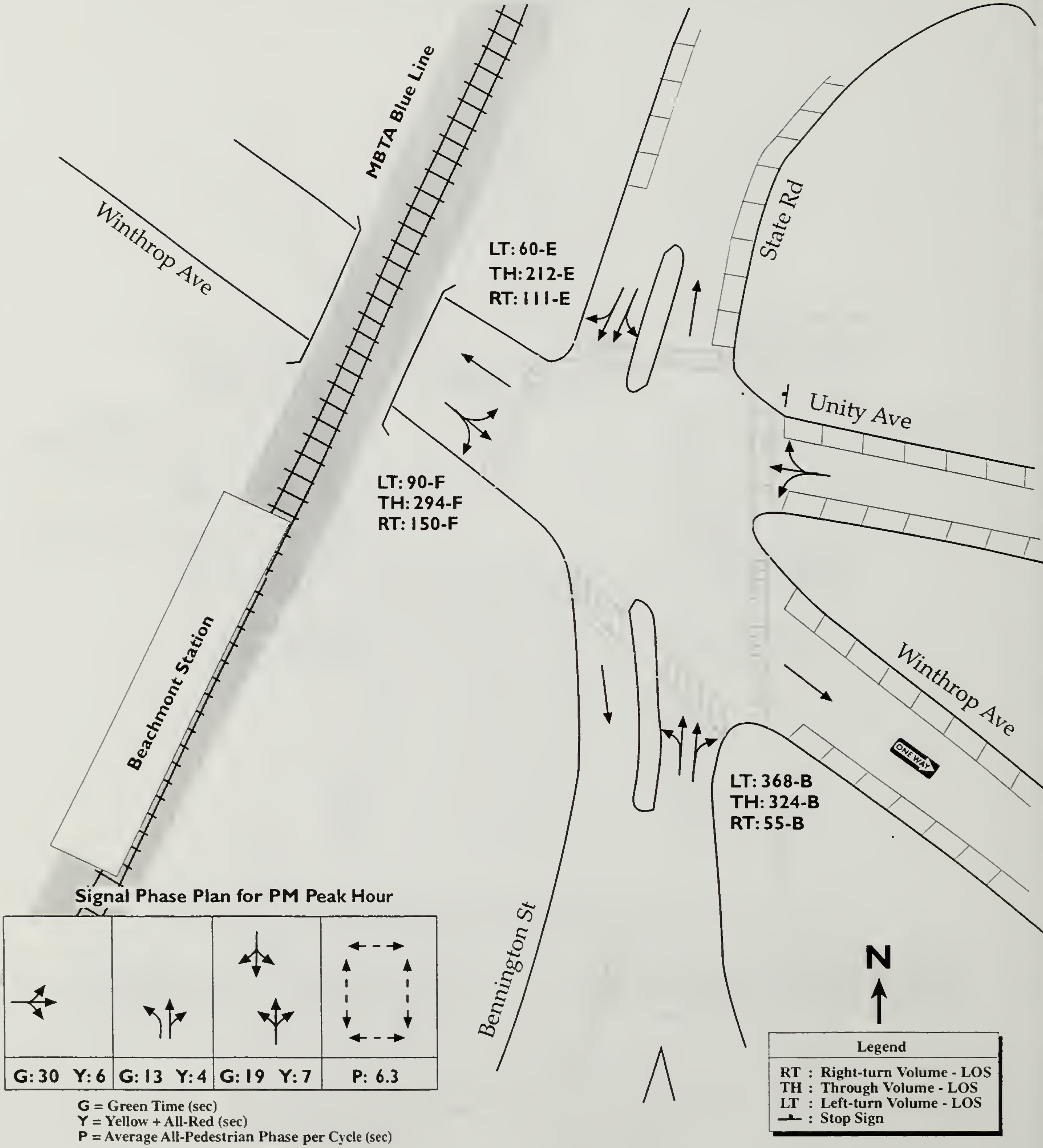
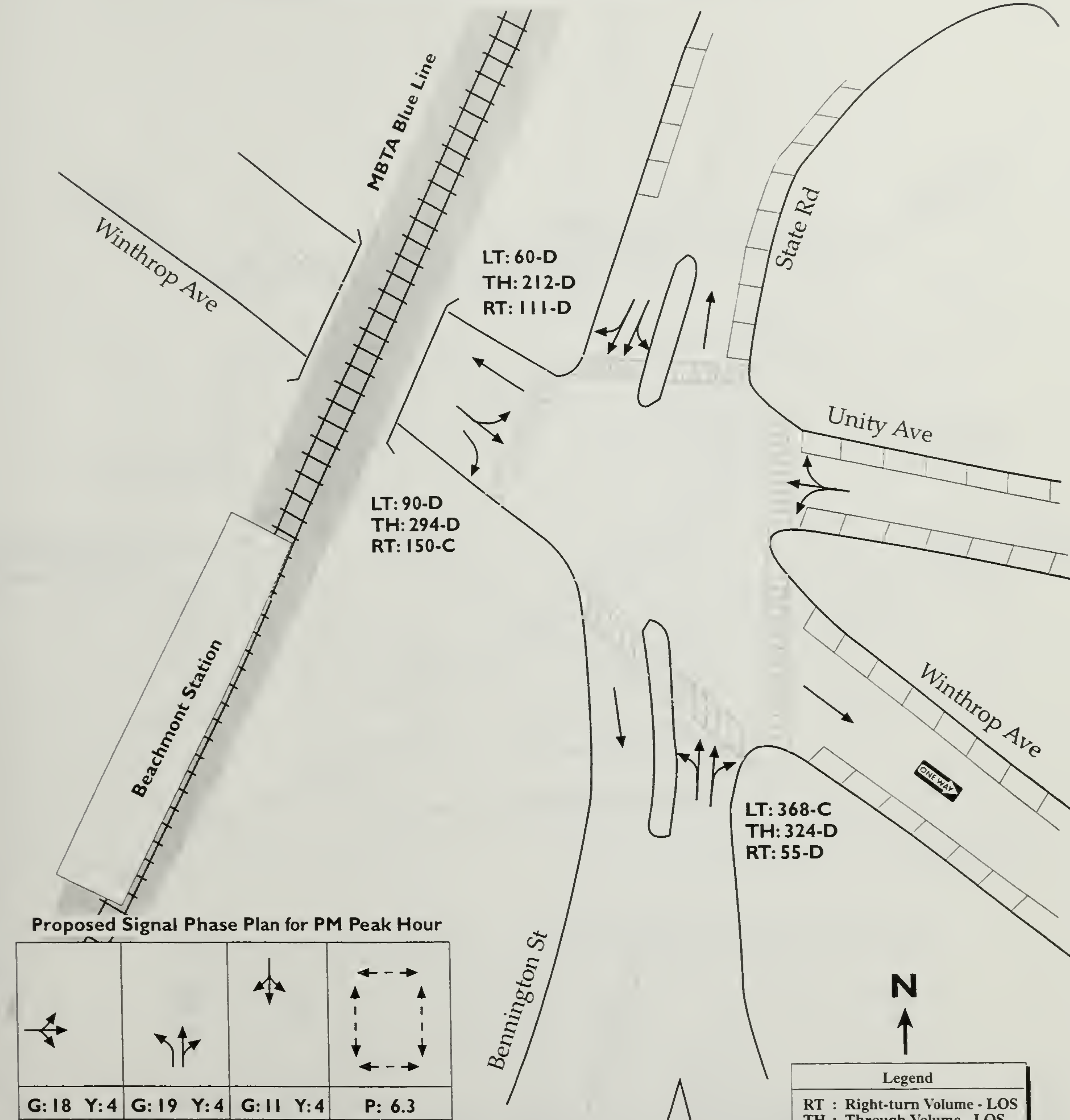
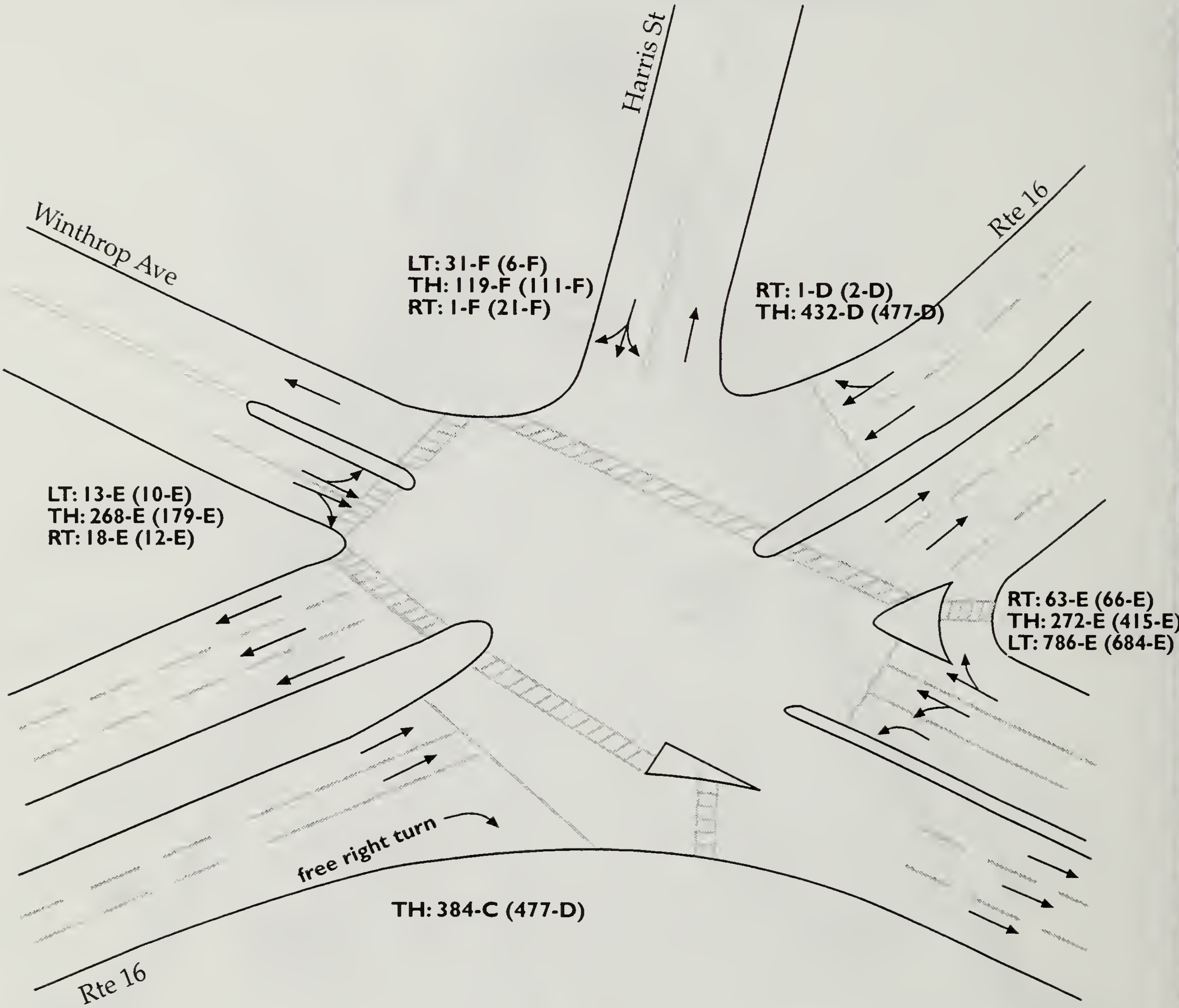


Figure 3–14
Proposed Geometric Improvements and Signal Phase Plan
Bennington Street/State Road @ Winthrop Avenue, Revere



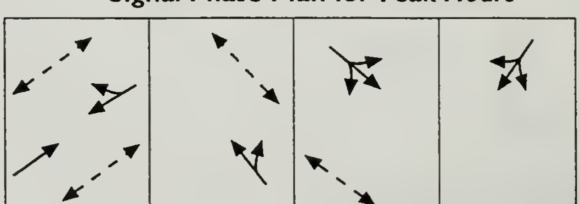
G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

Figure 3–15
Existing Geometry, Traffic Volumes and Signal Phase Plan
Route 16 @ Winthrop Avenue/Harris Street, Revere



Legend
RT : AM Right-turn Volume - LOS (PM Volume - LOS)
TH : AM Through Volume - LOS (PM Volume - LOS)
LT : AM Left-turn Volume - LOS (PM Volume - LOS)

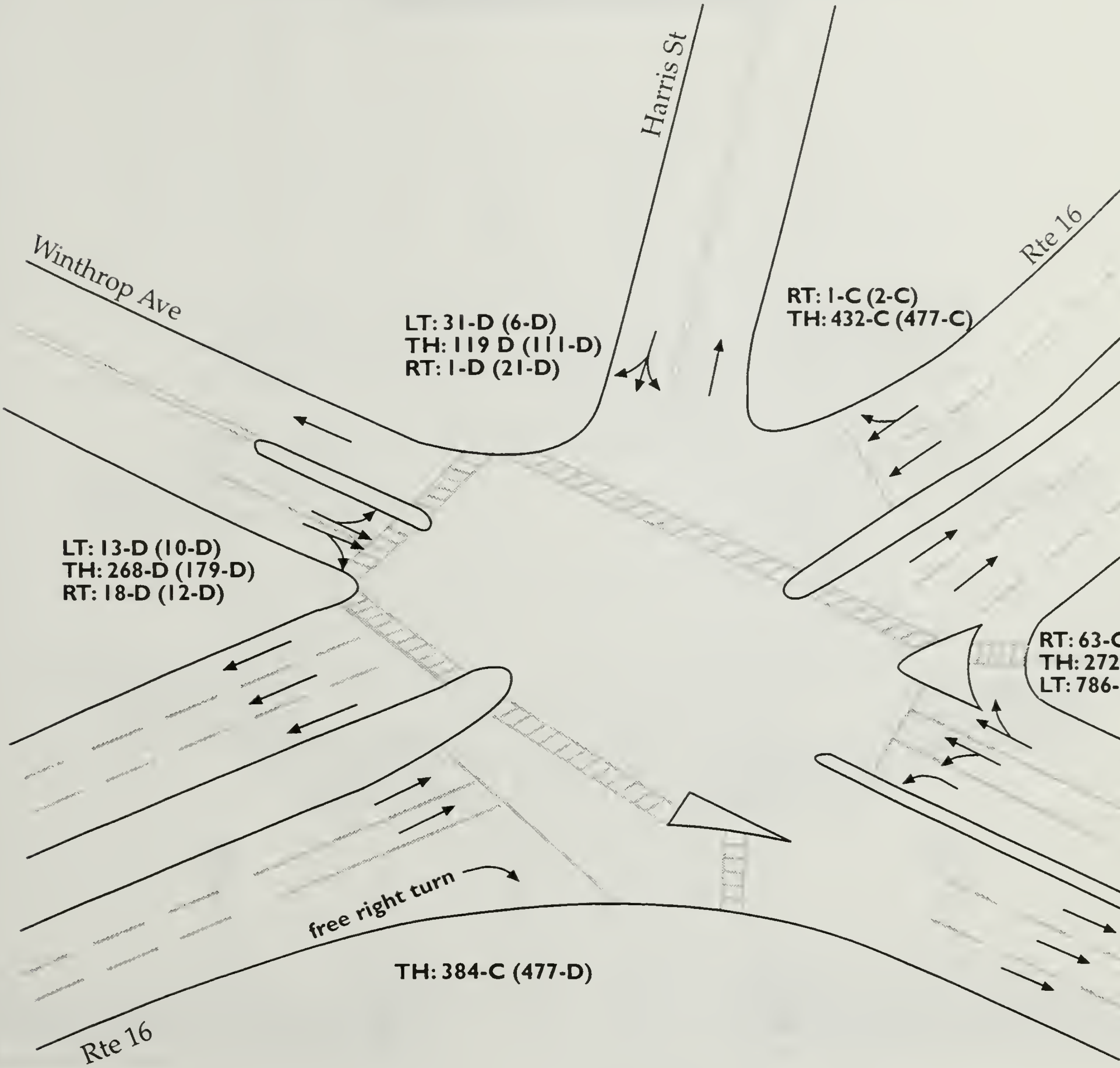
Signal Phase Plan for Peak Hours



AM	G: 60 Y: 6	G: 40 Y: 6	G: 19 Y: 6	G: 15 Y: 6
PM	G: 60 Y: 6	G: 40 Y: 6	G: 20 Y: 6	G: 15 Y: 6

G = Green Time (sec)
Y = Yellow + All-Red (sec)

Figure 3–16
Proposed Signal Phase Plan and Estimated Levels of Service
Route 16 @ Winthrop Avenue/Harris Street, Revere

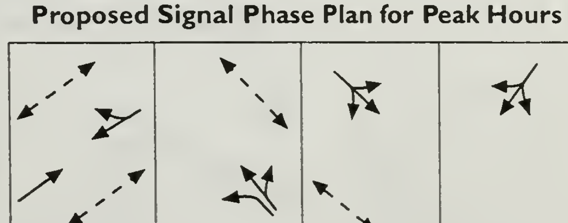


N

Legend

RT : AM Right-turn Volume - LOS (PM Volume - LOS)
TH : AM Through Volume - LOS (PM Volume - LOS)
LT : AM Left-turn Volume - LOS (PM Volume - LOS)

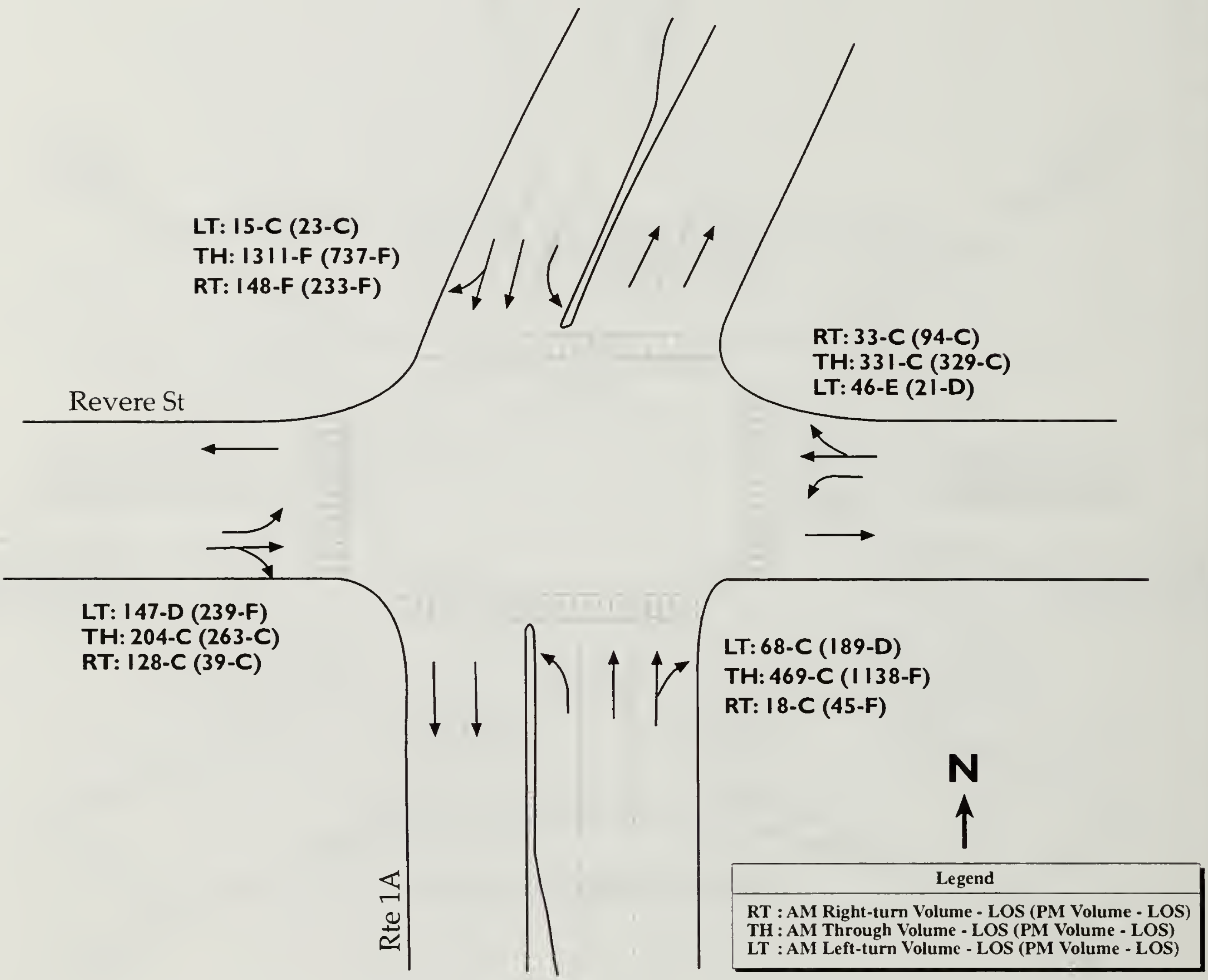
Proposed Signal Phase Plan for Peak Hours



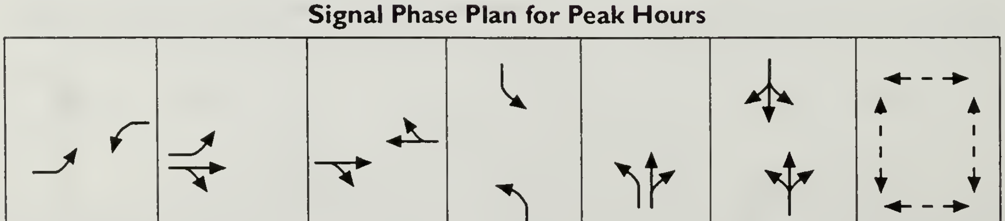
AM (sec)	G: 22 Y: 6	G: 27 Y: 6	G: 7 Y: 6	G: 10 Y: 6
PM (sec)	G: 21 Y: 6	G: 26 Y: 6	G: 11 Y: 6	G: 8 Y: 6

G = Green Time (sec)
Y = Yellow + All-Red (sec)

Figure 3–17
Existing Geometry, Traffic Volumes and Signal Phase Plan
Route 1A @ Revere Street, Revere



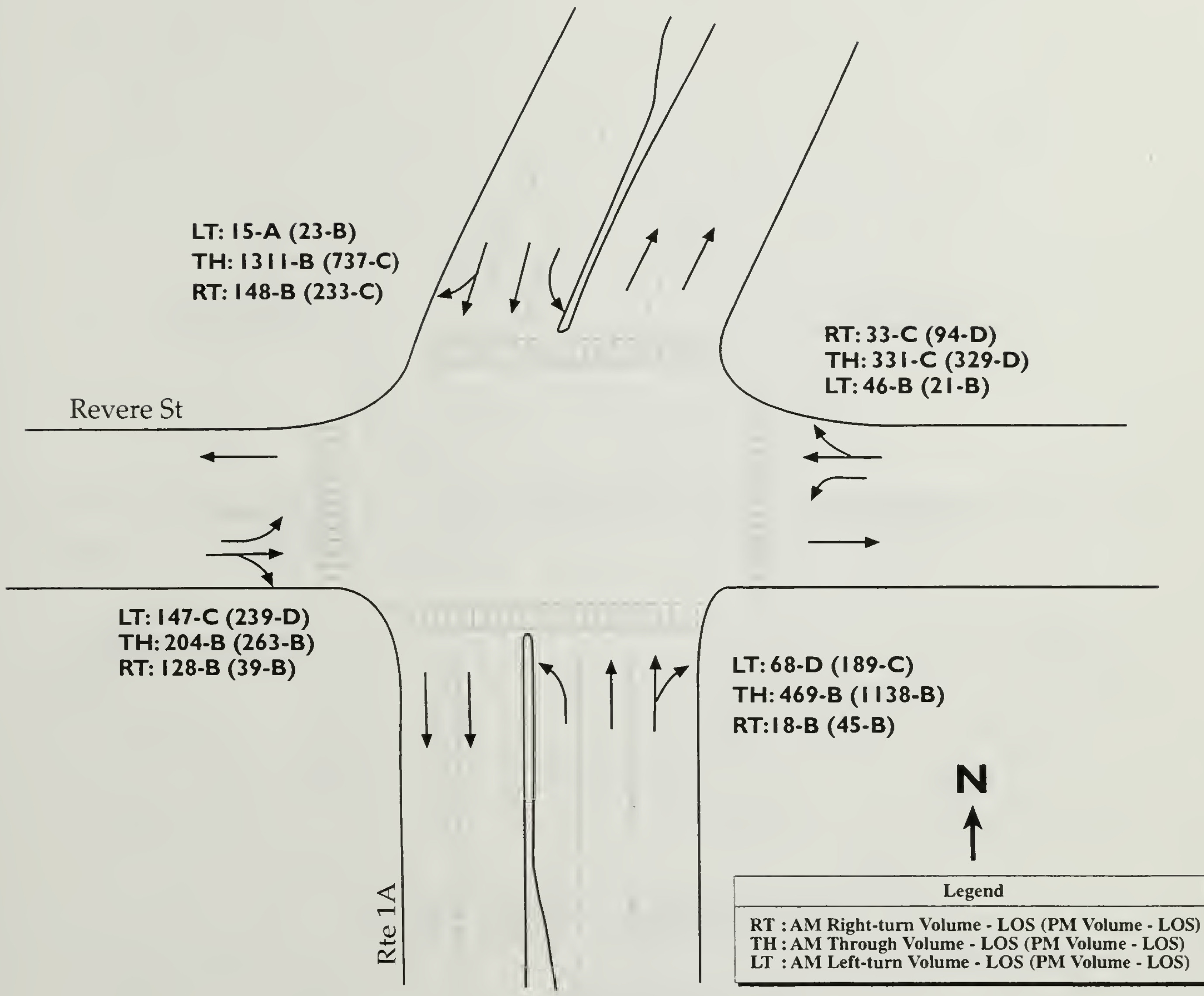
Signal Phase Plan for Peak Hours



AM	G: 7 Y: 5	G: 8 Y: 5	G: 50 Y: 5	G: 7 Y: 5	G: 10 Y: 0	G: 34 Y: 5	P: 0
PM	G: 8 Y: 5	G: 2 Y: 5	G: 50 Y: 5	G: 6 Y: 5	G: 9 Y: 0	G: 27 Y: 5	P: 2

G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

Figure 3–18
Proposed Signal Phase Plan and Estimated Levels of Service
Route 1A @ Revere Street, Revere

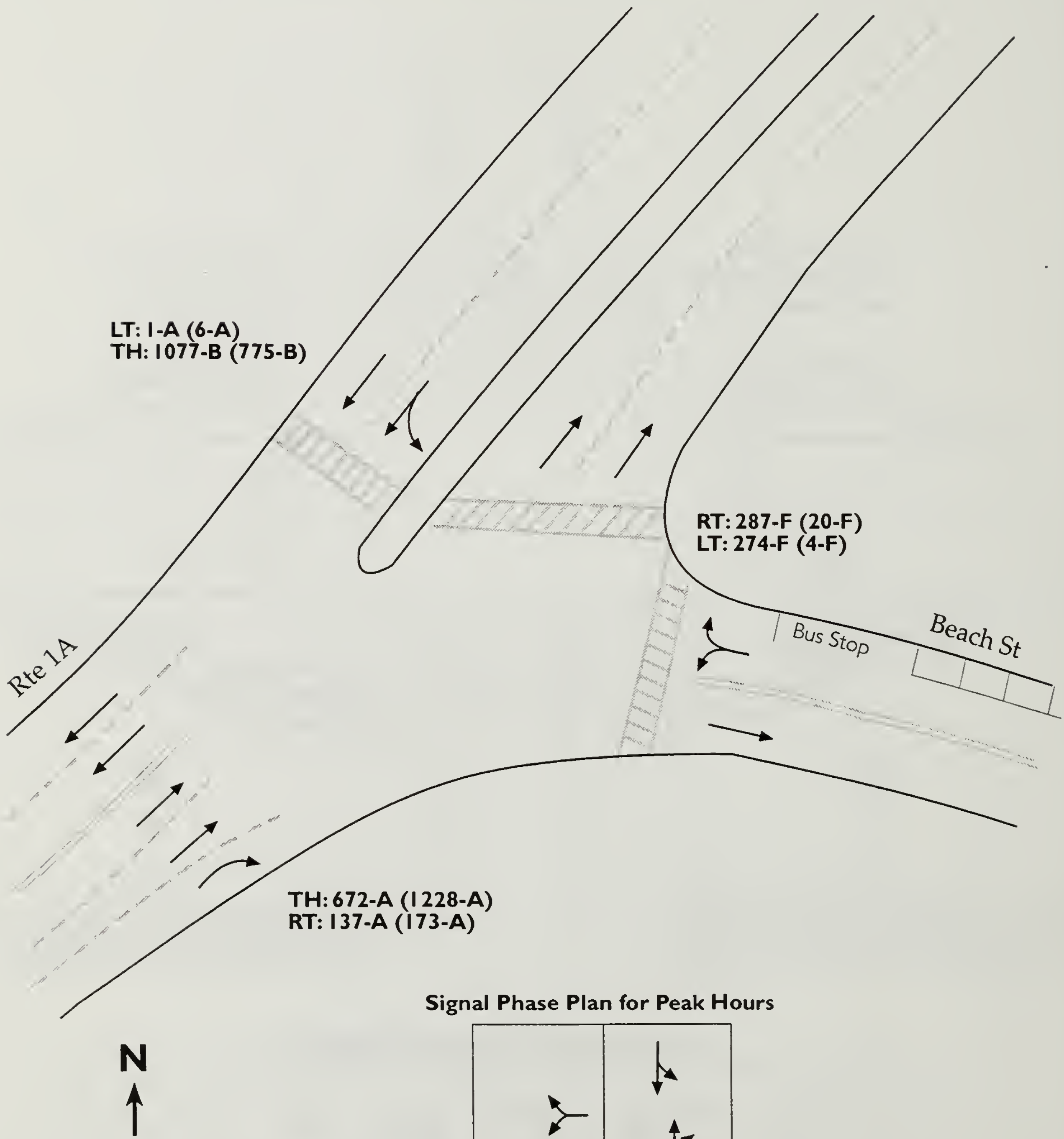


Proposed Signal Phase Plan for Peak Hours

			AM only	PM only		
AM	G: 3.5 Y: 3	G: 17 Y: 4	G: 3 Y: 3	G: 0 Y: 0	G: 32.5 Y: 4	P: 0
PM	G: 7.5 Y: 3	G: 18.5 Y: 4	G: 0 Y: 0	G: 6 Y: 3	G: 24 Y: 4	P: 2

G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

Figure 3–19
Existing Geometry, Traffic Volumes and Signal Phase Plan
Route 1A @ Beach Street, Revere



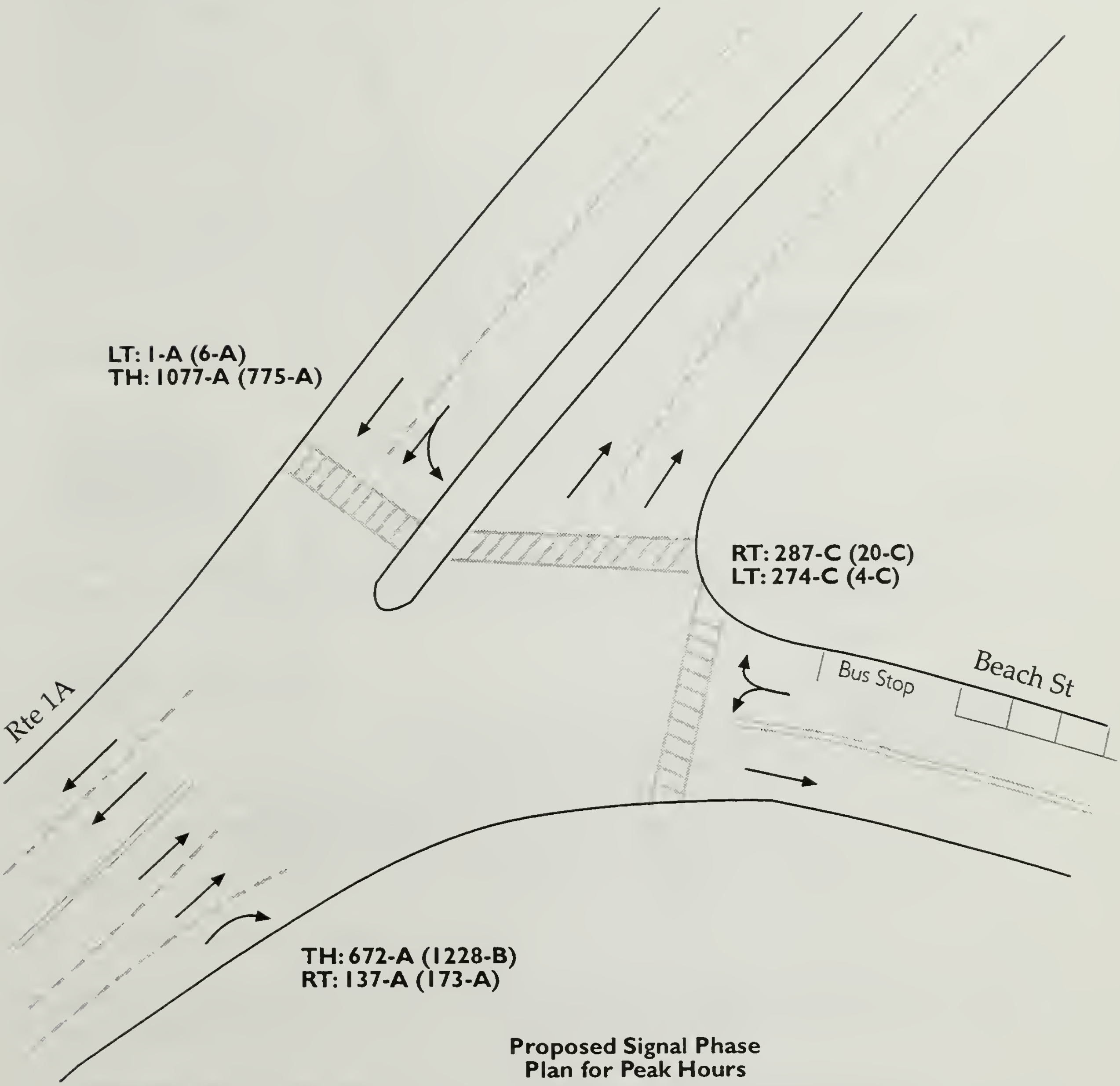
Legend
RT : AM Right-turn Volume - LOS (PM Volume - LOS)
TH : AM Through Volume - LOS (PM Volume - LOS)
LT : AM Left-turn Volume - LOS (PM Volume - LOS)

Signal Phase Plan for Peak Hours

	Phase 1	Phase 2
AM	G: 20 Y: 6	G: 68 Y: 6
PM	G: 21 Y: 6	G: 70 Y: 6

G = Green Time (sec)
Y = Yellow + All-Red (sec)

Figure 3–20
Proposed Signal Phase Plan and Estimated Levels of Service
Route 1A @ Beach Street, Revere



N

Proposed Signal Phase Plan for Peak Hours

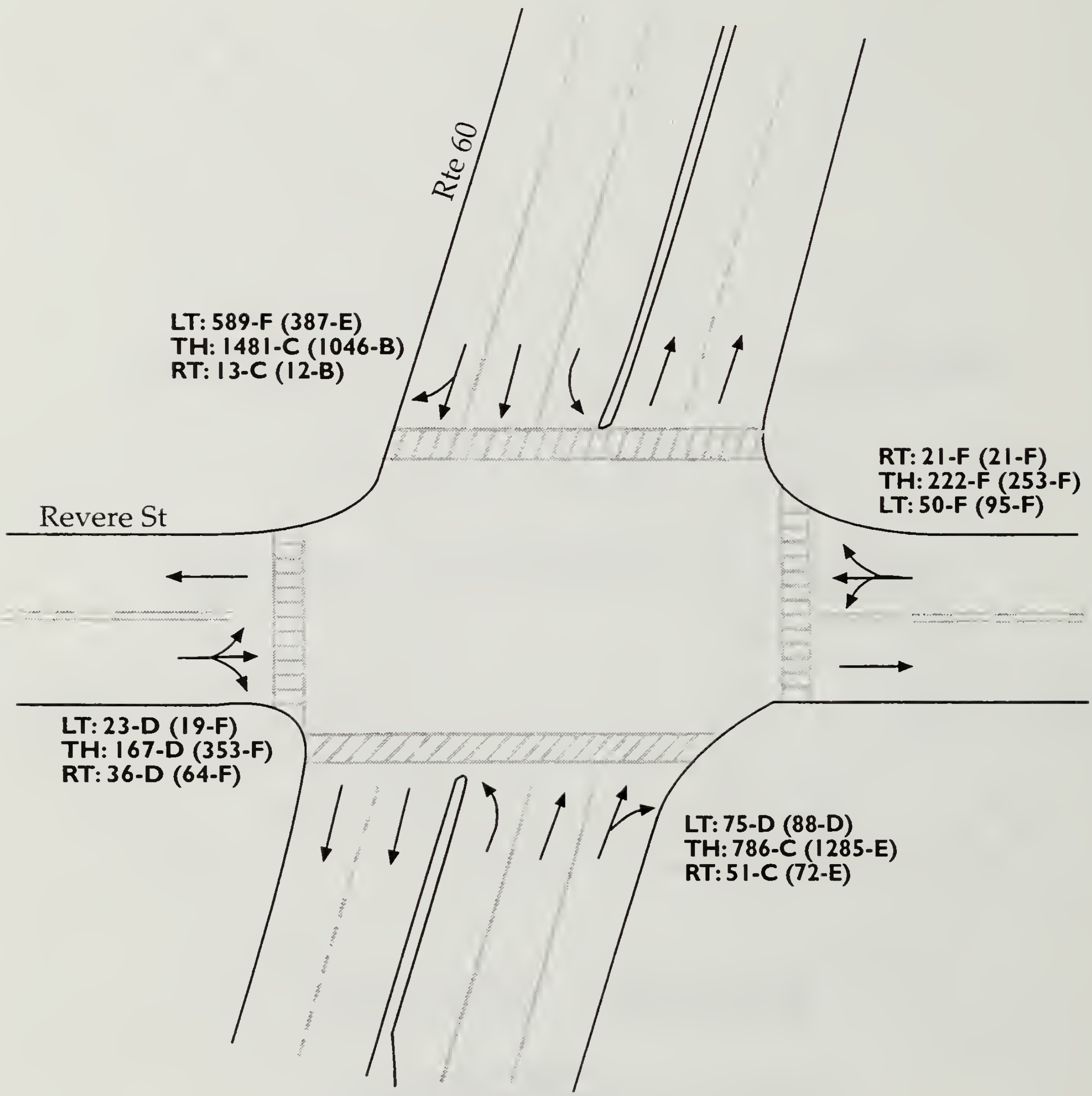
AM	G: 16 Y: 4	G: 36 Y: 4
PM	G: 18 Y: 4	G: 34 Y: 4

G = Green Time (sec)
Y = Yellow + All-Red (sec)

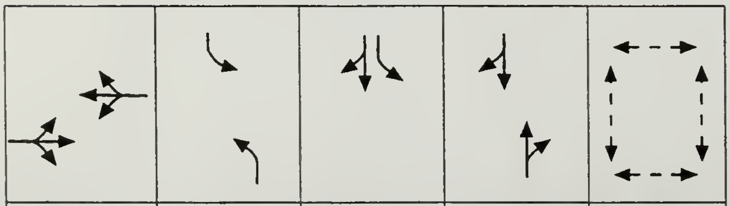
Legend

RT : AM Right-turn Volume - LOS (PM Volume - LOS)
TH : AM Through Volume - LOS (PM Volume - LOS)
LT : AM Left-turn Volume - LOS (PM Volume - LOS)

Figure 3–21
Existing Geometry, Traffic Volumes and Signal Phase Plan
Route 60 @ Revere Street, Revere



Signal Phase Plan for Peak Hours



	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
AM	G: 26 Y: 5	G: 11 Y: 5	G: 16 Y: 5	G: 43 Y: 5	P: 3
PM	G: 28 Y: 5	G: 14 Y: 5	G: 11 Y: 5	G: 50 Y: 5	P: 3

G = Green Time (sec)
Y = Yellow + All-Red (sec)
P = Average All-Pedestrian Phase per Cycle (sec)

N

Legend
RT : AM Right-turn Volume - LOS (PM Volume - LOS) TH : AM Through Volume - LOS (PM Volume - LOS) LT : AM Left-turn Volume - LOS (PM Volume - LOS)

The following intersections of Revere Beach Parkway are recommended for signal coordination:

- Lewis Street
- Second Street
- Spring Street
- South Ferry Street
- Vine Street
- Everett Avenue
- Washington Street
- Garfield/Webster Street

A preliminary traffic signal analysis does show that it is possible to provide improved service on Revere Beach Parkway with signal coordination. However, adjusting the traffic signals will negatively affect some cross streets unless changes are made to their approaches as well. Most cross streets that need improvement only require the addition of a separate left-turn lane.

The following cross streets require no additional work with Revere Beach Parkway signal coordination:

- Lewis Street
- Spring Street
- South Ferry Street
- Vine Street

The following streets require separate left-turn lanes at their intersection with Revere Beach Parkway in order to operate properly with Revere Beach Parkway signal coordination:

- Everett Street
- Washington Street
- Garfield/Webster Street

Finally, Second Street requires major reconstruction in order to provide acceptable traffic signal operations, due to the high traffic volumes. Left-turn lanes on Second Street are required, but not sufficient. A right-turn lane on Revere Beach Parkway eastbound is one improvement that will result in a good level of service. However, since there is no breakdown lane on this section of Revere Beach Parkway, this will require a widening of the roadway by 12 feet in this area.

3.5 Pedestrian Safety Improvements

This section describes existing conditions and proposed improvements for the four intersections that were identified as in need of pedestrian safety improvement analysis:

- Bennington Street at Saratoga Street, East Boston
- Broadway (Route 99) at Ferry Street, Everett
- Revere Beach Boulevard at Oak Island Road, Revere
- Broadway (Route 107) at Central Avenue, Revere

The first location, Saratoga Street at Bennington Street in East Boston, was identified as unsafe for pedestrians by residents at the East Boston public meeting, although Registry of Motor Vehicle accident records show only three reported accidents involving pedestrians between 1994 and 1996. The other three intersections had five or more reported accidents involving pedestrians between 1994 and 1996.

3.5.1 Bennington Street at Saratoga Street, East Boston

This intersection is located across from the Orient Heights Blue Line station. Three accidents involving pedestrians were reported between 1994 and 1996. None of the accidents involved a fatality; the pedestrians' ages varied. The month of year varied, but two of the three accidents occurred on a Saturday, and the third occurred on a Friday. The accidents all occurred between 3:00 and 5:00 PM. Two accidents occurred during daylight. No citation was issued to the operator in two accidents, but the third operator received a citation for driving with defective equipment.

Highly visible crosswalks striped with diagonal lines cross each intersection leg. Pedestrian buttons are located on all four corners and on two of the channelized islands. The exclusive pedestrian phase is 25 seconds. This time is adequate to cross three of the intersection approaches, but not the northbound Bennington Street approach. Although a pedestrian button is located halfway across the northbound Bennington Street approach, there are no signs to inform a pedestrian that it exists. Furthermore, expecting a pedestrian to cross Bennington Street halfway and then wait another 127 seconds for the cycle to return to the pedestrian phase so that the pedestrian may complete the crossing is unrealistic.

"No Right Turn on Red" signs exist on three approaches. Right-turns are permitted on the westbound Saratoga Street approach. The RTOR prohibitions are continually violated, but especially the one for the northbound Bennington Street approach. A "Yield to Pedestrians in Crosswalk" sign has been installed on this approach to warn motorists that crossing pedestrians may be present and that they have the right of way. Motorists also frequently violated the exclusive pedestrian phase, making all movements during it. Figure 2-22 shows the existing conditions at the intersection.

Proposed Improvements

Figure 3-23 shows the proposed improvements. One is to extend the exclusive pedestrian phase from 25 seconds to 28 seconds. This extension is based on a crossing distance of 125 feet (the distance across the northbound Bennington Street leg) and a crossing speed of 4.5 feet per second. A one-second all red is suggested at the end of the pedestrian phase to allow extra time for pedestrians to clear the intersection. The southwest corner of the intersection could also be extended to shorten the crossing distance.

Many pedestrians have a misconception about the "Walk/Don't Walk" pedestrian indicators, believing they should be able to get all the way across the street during the "Walk" indication (before the "Don't walk" indication begins). A considerable amount of research has been devoted to educating pedestrians on how to understand pedestrian indications at signalized intersections, and instructional signs have been developed. A sign such as the one presented in Figure 3-24, may be warranted at this intersection. Finally, greater enforcement is needed at this intersection of the RTOR prohibition and of the exclusive pedestrian phase.

3.5.2 Broadway (Route 99) at Ferry Street, Everett

This four-way intersection, also known as Glendale Square, has some of the heaviest motor vehicle traffic volumes in Everett. Five pedestrian accidents were reported between 1994 and 1996. None of the accidents involved a fatality. The pedestrians' ages varied. Four of the five accidents occurred during the winter months of November, December and January. Two of the five accidents occurred during daylight; the other three occurred during darkness with the road lighted. No violations were issued to any of the motor vehicle operators involved in the accidents.

This intersection is fully equipped with working pedestrian devices. The marked crosswalks are visible, and pedestrian buttons exist on all four corners. The exclusive pedestrian phase is 24 seconds, which meets the minimum time required (based on a walking speed of 4.5 feet per second). RTOR prohibitions apply to all approaches, minimizing the potential for conflict with crossing pedestrians. Figure 3-25 shows the existing conditions.

Accident reports for the five pedestrian accidents were obtained from the Everett Police Department and plotted on a collision diagram (Figure 3-26). In each case, the pedestrian entered the roadway without pushing the pedestrian button and without watching out for moving vehicles. For example, one pedestrian was pushed into the roadway by a group of friends. In another case, the pedestrian was noted as being under the influence of alcohol when struck. Furthermore, several of the accidents occurred outside the crosswalk area. A recent traffic study conducted by the city at this intersection indicated that only about 10 in 100 people use the pedestrian button to cross.

No major pedestrian improvements are recommended for this intersection at this time. Further study of this intersection could consider erecting devices to physically prevent people from crossing midblock and installing pedestrian crossing signs to alert motorists.

3.5.3 Revere Beach Boulevard at Oak Island Street, Revere

This T-intersection is located amidst heavy pedestrian generators: Revere Beach, Kelly's Roast Beef, the Oak Island Skilled Nursing Facility, and a multistory apartment complex. Seven pedestrian accidents were reported between 1994 and 1996. None of the accidents involved a fatality. The pedestrians' ages varied. The month of year, day of week, and time of day also varied, although five of the seven accidents occurred during darkness with the road lighted. Four of the 7 operators received no citation, two received citations for failure to yield right-of-way to a pedestrian, and one received a citation for driving under the influence of alcohol.

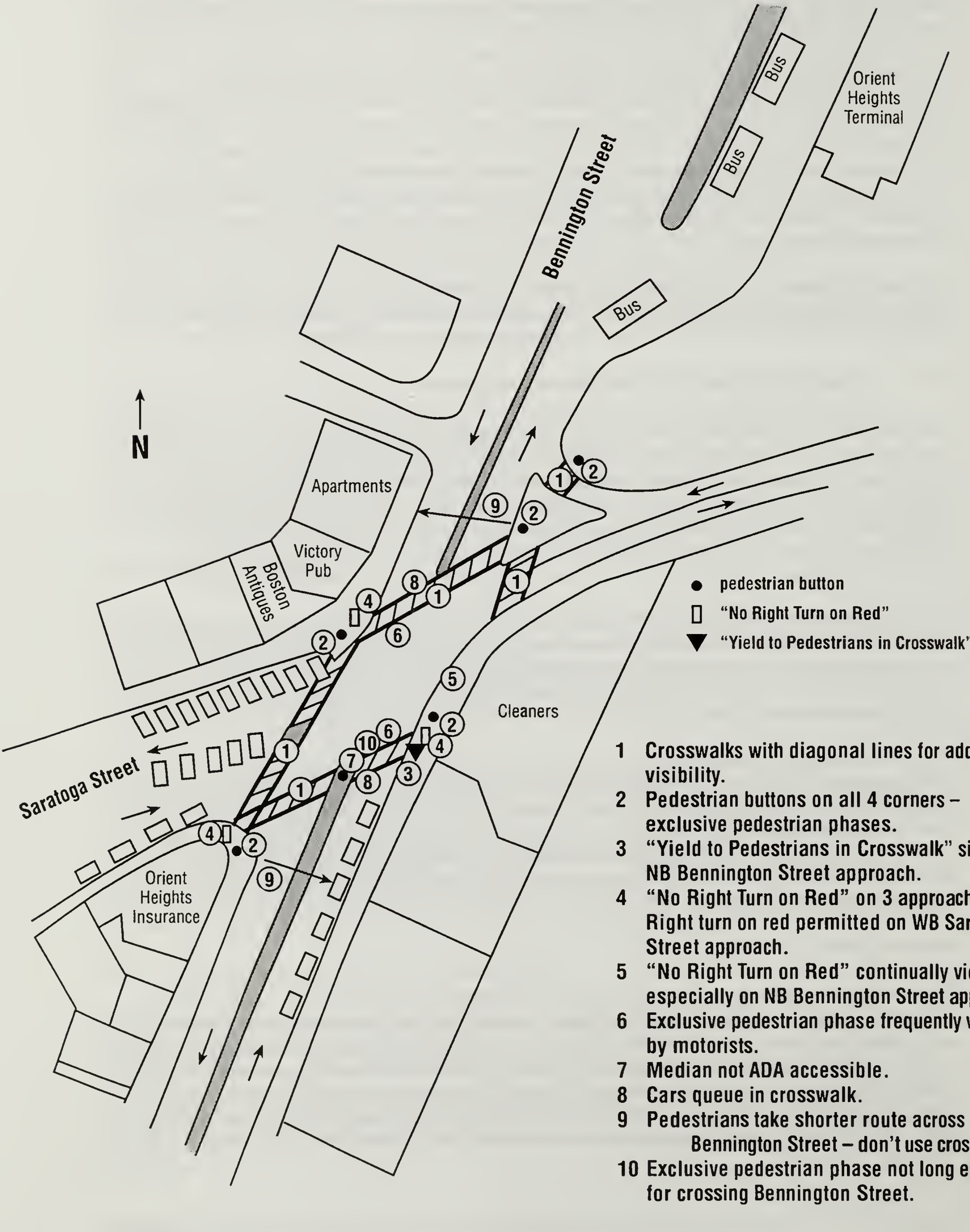
There are six crosswalks in or near the intersection: four of them cross Revere Beach Boulevard and two cross Oak Island Street. The crosswalks are standard white lines marking both edges of the crosswalk, but are heavily faded. A pedestrian signal is located at the northernmost crosswalk on Revere Beach Boulevard across from the apartment complex, but the "Walk/Don't Walk" indications are broken.

On-street parking is permitted along the east side of Revere Beach Boulevard and along a portion of the west side. The crosswalks emerge from the line of parked vehicles, making it difficult for pedestrians and motorists to see each other. "State Law: Yield to Pedestrians in Crosswalk" signs have been placed in advance of three of the crosswalks to warn motorists, but these signs are often obscured by parked vehicles and other activity (for example, moving vehicles, pedestrians, etc.) in the area. Figure 3-27 shows the existing configuration and the surrounding land uses of the intersection.

Proposed Improvements

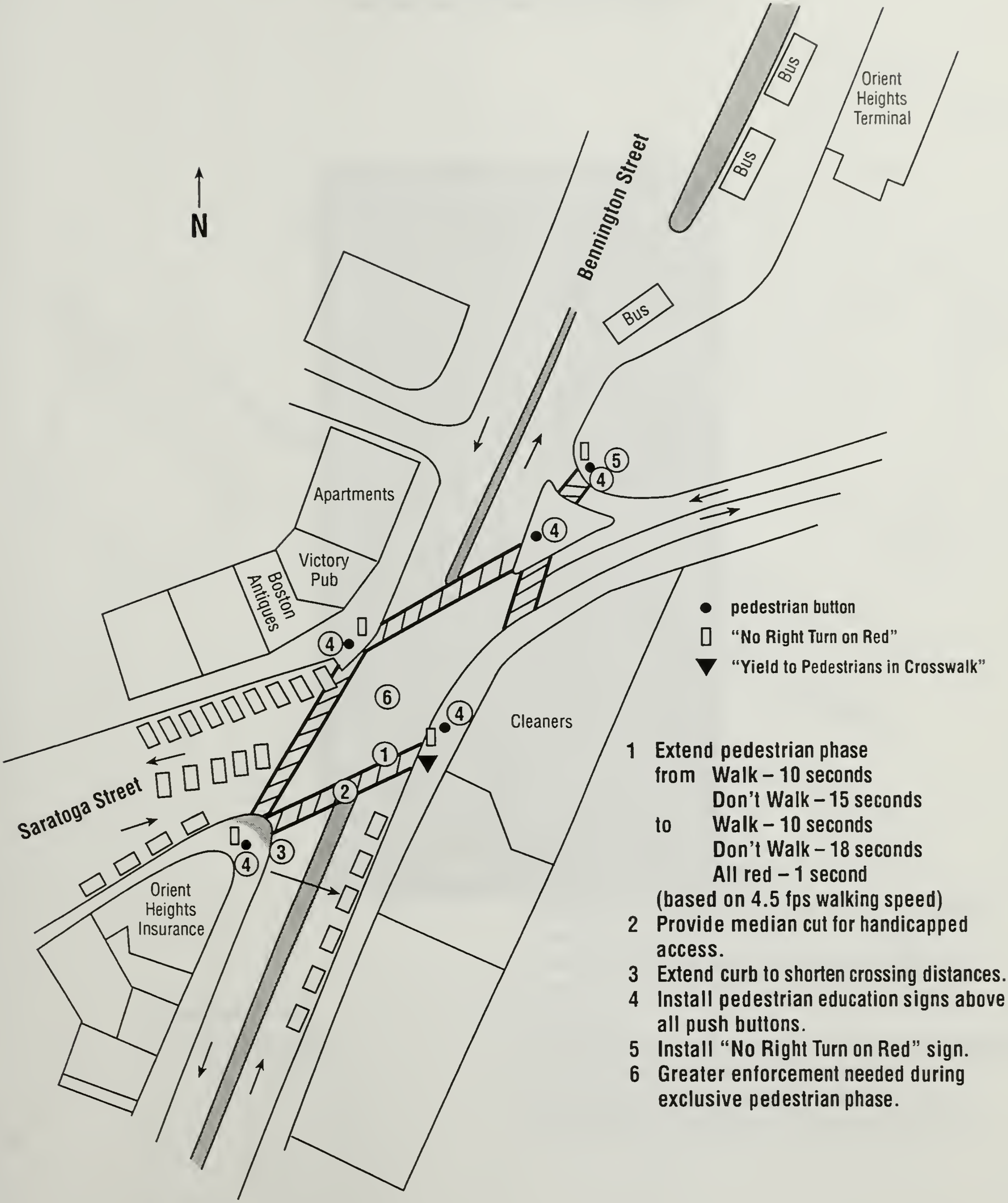
Figure 3-28 shows the proposed improvements. Pedestrian staging areas (a.k.a. "neckdowns") are recommended at crosswalk locations where on-street parking is permitted. These neckdowns are physical extensions of the sidewalk. Pedestrians standing on the edge of the neckdowns have a better view of oncoming traffic and motorists have a better view of crossing pedestrians. The neckdowns reduce crossing distances and help make the crosswalks more prominent. The plan also calls for improved visibility of the crosswalks through contrasting paving material and/or color. To further encourage pedestrians to use the crosswalks, "Cross Only at Crosswalk" signs

Figure 3-22
Existing Conditions Related to Pedestrian Safety
Bennington Street @ Saratoga Street, East Boston



1 Crosswalks with diagonal lines for added visibility.
2 Pedestrian buttons on all 4 corners – exclusive pedestrian phases.
3 "Yield to Pedestrians in Crosswalk" sign on NB Bennington Street approach.
4 "No Right Turn on Red" on 3 approaches. Right turn on red permitted on WB Saratoga Street approach.
5 "No Right Turn on Red" continually violated, especially on NB Bennington Street approach.
6 Exclusive pedestrian phase frequently violated by motorists.
7 Median not ADA accessible.
8 Cars queue in crosswalk.
9 Pedestrians take shorter route across Bennington Street – don't use crosswalks.
10 Exclusive pedestrian phase not long enough for crossing Bennington Street.

Figure 3-23
Proposed Pedestrian Safety Improvements
Bennington Street @ Saratoga Street, East Boston



- ● pedestrian button
- ▯ "No Right Turn on Red"
- ▼ "Yield to Pedestrians in Crosswalk"

1 Extend pedestrian phase
from Walk – 10 seconds
Don't Walk – 15 seconds
to Walk – 10 seconds
Don't Walk – 18 seconds
All red – 1 second
(based on 4.5 fps walking speed)

2 Provide median cut for handicapped access.

3 Extend curb to shorten crossing distances.

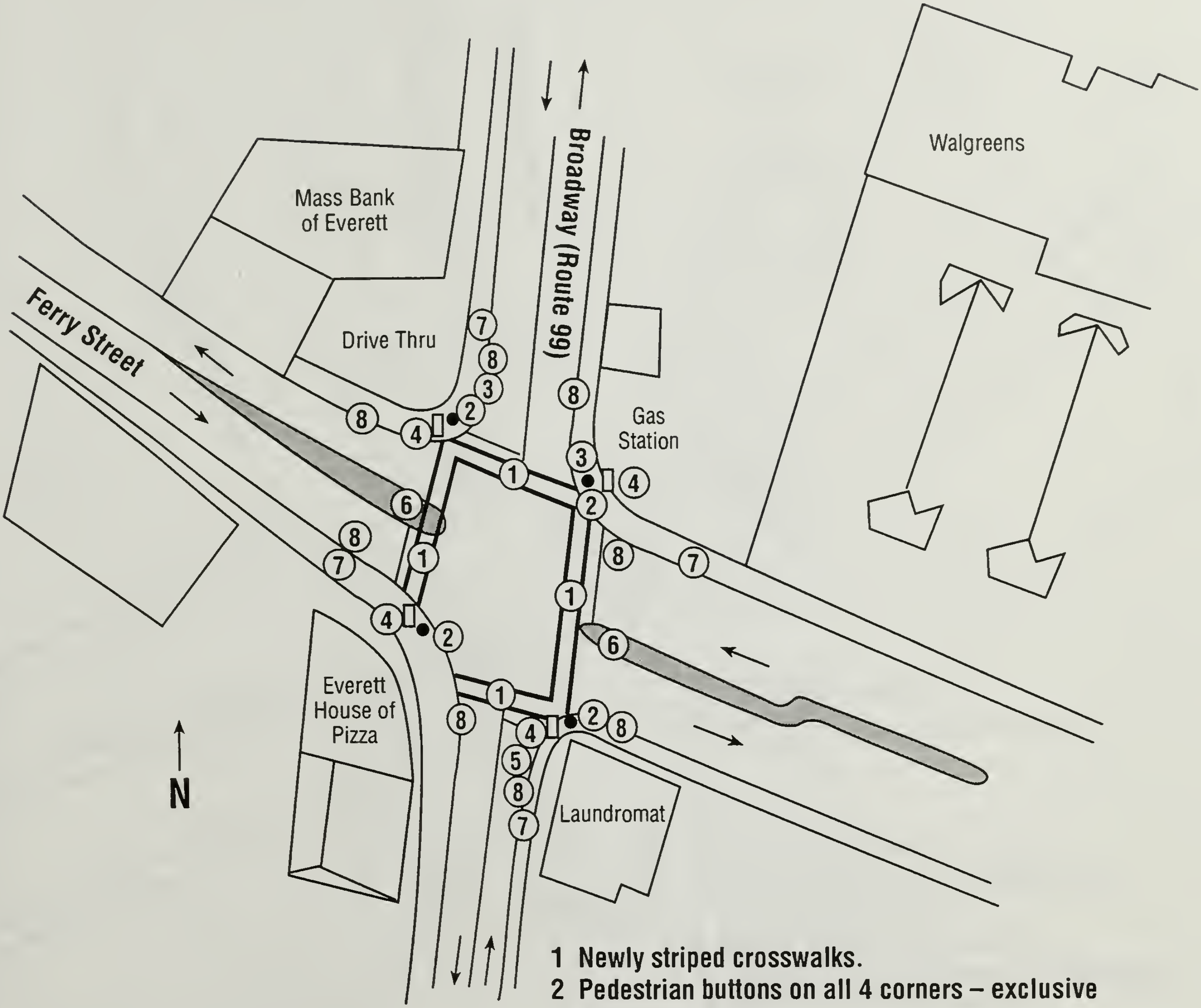
4 Install pedestrian education signs above all push buttons.

5 Install "No Right Turn on Red" sign.

6 Greater enforcement needed during exclusive pedestrian phase.

Figure 3-24
Pedestrian Education Sign
Explaining Crossing Indications

Figure 3-25
Existing Conditions Related to Pedestrian Safety
Broadway (Route 99) @ Ferry Street, Everett

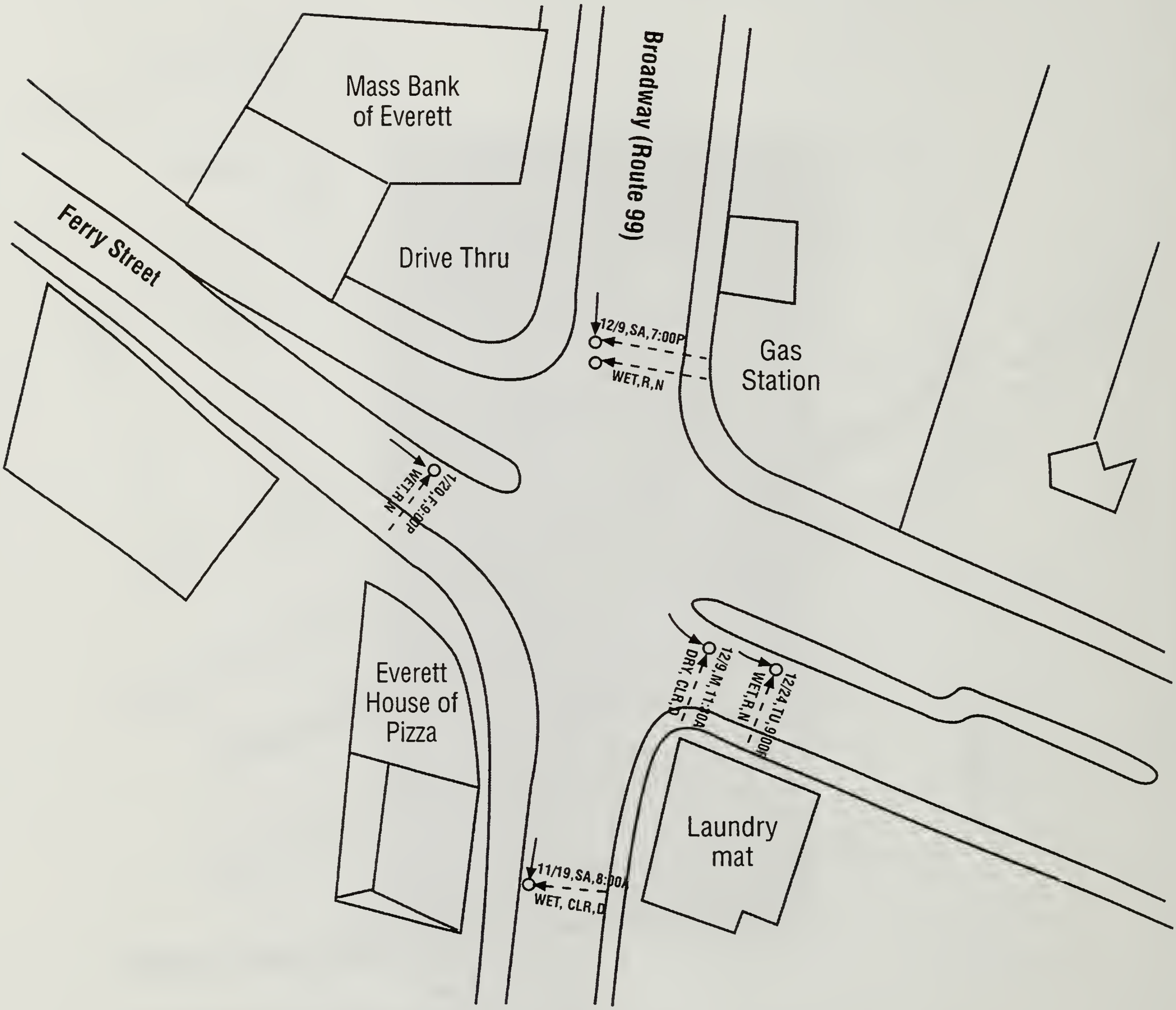


1 Newly striped crosswalks.
2 Pedestrian buttons on all 4 corners – exclusive pedestrian phase.
3 Audible walk indication for visually impaired.
4 "No Right Turn on Red" on all 4 approaches.
5 Bus stop.
6 Pedestrian refuge available on Ferry Street approaches.
7 Adequate sidewalks on all approaches.
8 On-street parking adequately set back on all approaches – visibility for pedestrian is good.

● pedestrian button

▯ "No Right Turn on Red"

Figure 3-26
Collision Diagram (1994–96)
Broadway (Route 99) @ Ferry Street, Everett

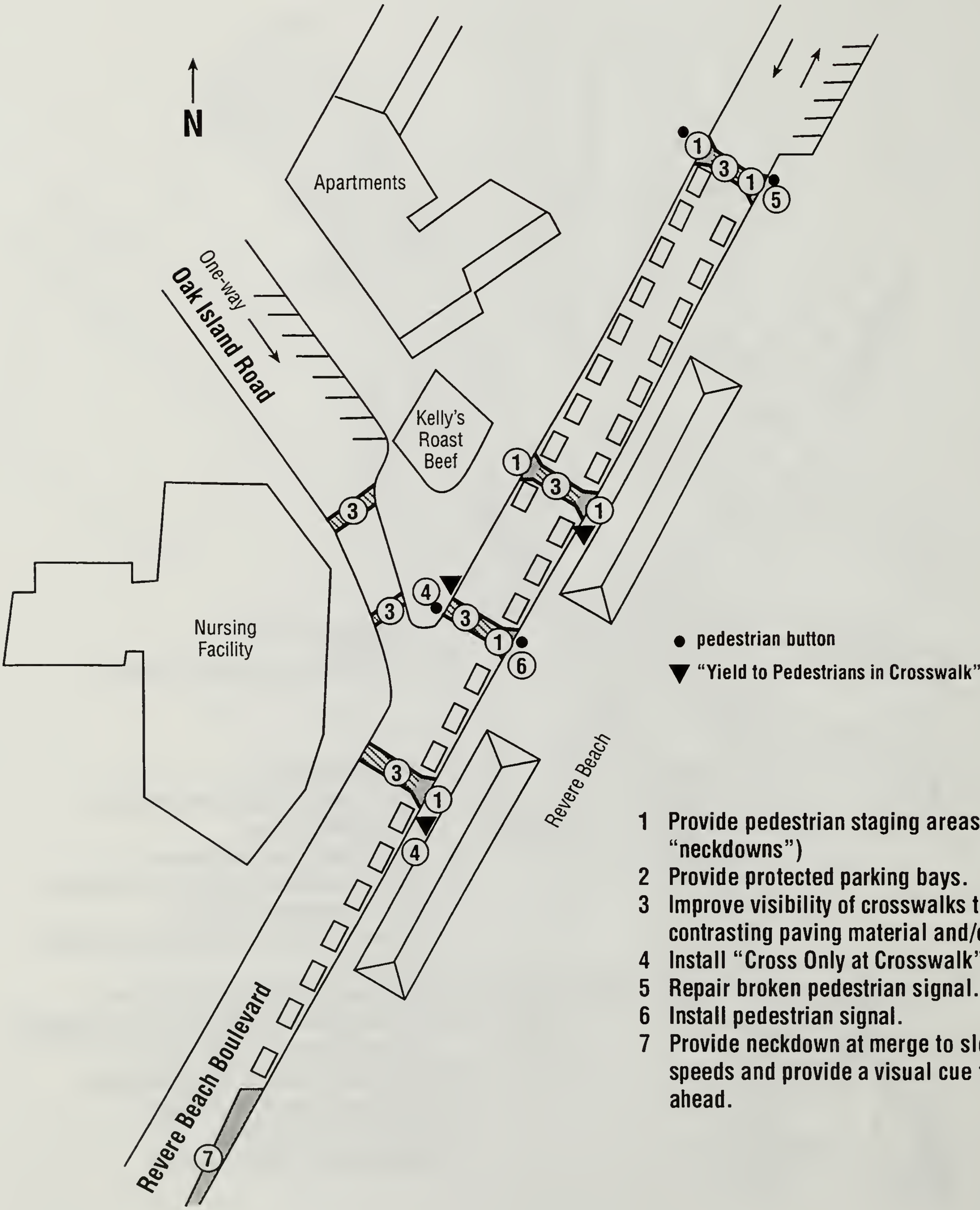


SYMBOLS	TYPE OF COLLISIONS	SHOW FOR EACH ACCIDENT
← Moving vehicle ← - - - Pedestrian ○ Injury accident	Left turn Right angle	1. Date, Day, Time 2. Road surface conditions WET or DRY 3. Weather conditions CLR (clear) R (rain) 4. Light conditions D (daylight) N (night)

Figure 3-27
Existing Conditions Related to Pedestrian Safety
Revere Beach Boulevard @ Oak Island Street, Revere

1 Crosswalks faded.
2 "State Law: Yield to Pedestrians in Crosswalks" signs.
3 Heavy pedestrian generators.
4 Pedestrian buttons/signal – "Walk/Don't Walk" indications broken.
5 Pedestrian sight lines blocked by parked vehicles.
6 High vehicle speeds (30-40 mph).
7 Angled parking maneuvers – poor visibility for pedestrians and bicyclists.
8 Pedestrians do not use crosswalks.
9 Two lanes merge to one lane.
10 No room for bicyclists.
11 Sidewalks in good condition.

Figure 3-28
Proposed Pedestrian Safety Improvements
Revere Beach Boulevard @ Oak Island Street, Revere



1 Provide pedestrian staging areas (aka "neckdowns")
2 Provide protected parking bays.
3 Improve visibility of crosswalks through contrasting paving material and/or color.
4 Install "Cross Only at Crosswalk" signs.
5 Repair broken pedestrian signal.
6 Install pedestrian signal.
7 Provide neckdown at merge to slow vehicle speeds and provide a visual cue for whats ahead.

are recommended. These signs can be placed just below the "State Law: Yield to Pedestrians in Crosswalk" signs, making them highly visible to the pedestrian on the sidewalk.

Finally, it is recommended that the broken pedestrian signal across from the apartment complex be repaired and that a new pedestrian signal be installed at the corner of the intersection between Kelly's Roast Beef and Revere Beach. Because Oak Island Street is one-way with right turns only permitted onto Revere Beach Boulevard, the pedestrian signal will allow right turns out of Oak Island Street while also allowing elderly pedestrians to cross from the nursing facility to Revere Beach.

3.5.4 Broadway (Route 107) at Central Avenue, Revere

This T-intersection is located across from the fire station in downtown Revere. Five pedestrian accidents were reported between 1994 and 1996. None of the accidents involved a fatality. The pedestrians' ages varied. A review of the month of year shows that three of the five accidents occurred in November or January. All five accidents occurred during daylight. One operator received a violation, but it was not a moving violation.

No pedestrian devices were functioning at the time of the field visit. The crosswalks were heavily faded, and the "Walk/Don't Walk" indications were broken. The southeast corner at Citizens Bank was not equipped with a wheelchair ramp. Figure 3-29 shows the existing conditions of the intersection.

Proposed Improvements

Figure 3-30 shows the proposed improvements. This intersection is part of a closed-loop signal upgrade to be implemented at seven locations along Route 107 from Fenno Street to Revere Street. At the very least, the existing concurrent pedestrian phase will be repaired in the course of that project. Due to the high number of reported accidents at this location, however, it is recommended that an exclusive pedestrian phase be installed. This will allow pedestrians to cross the intersection without the interference of turning vehicles. The proposed plan also includes restriping the crosswalks and providing a wheelchair ramp on the southeast corner.

3.6 Parking Alternatives for Wonderland Station Users

In 1994, CTPS conducted an MBTA survey of Blue Line riders that investigated who was parking at Wonderland Station and where they were going. Since then, there have been improvements to the Blue Line. In March 1998, CTPS conducted a license plate survey at the Wonderland parking lots for the present study. The results showed that there was little change between who used Wonderland Station in 1994 and who used it in 1998 (Appendix F).

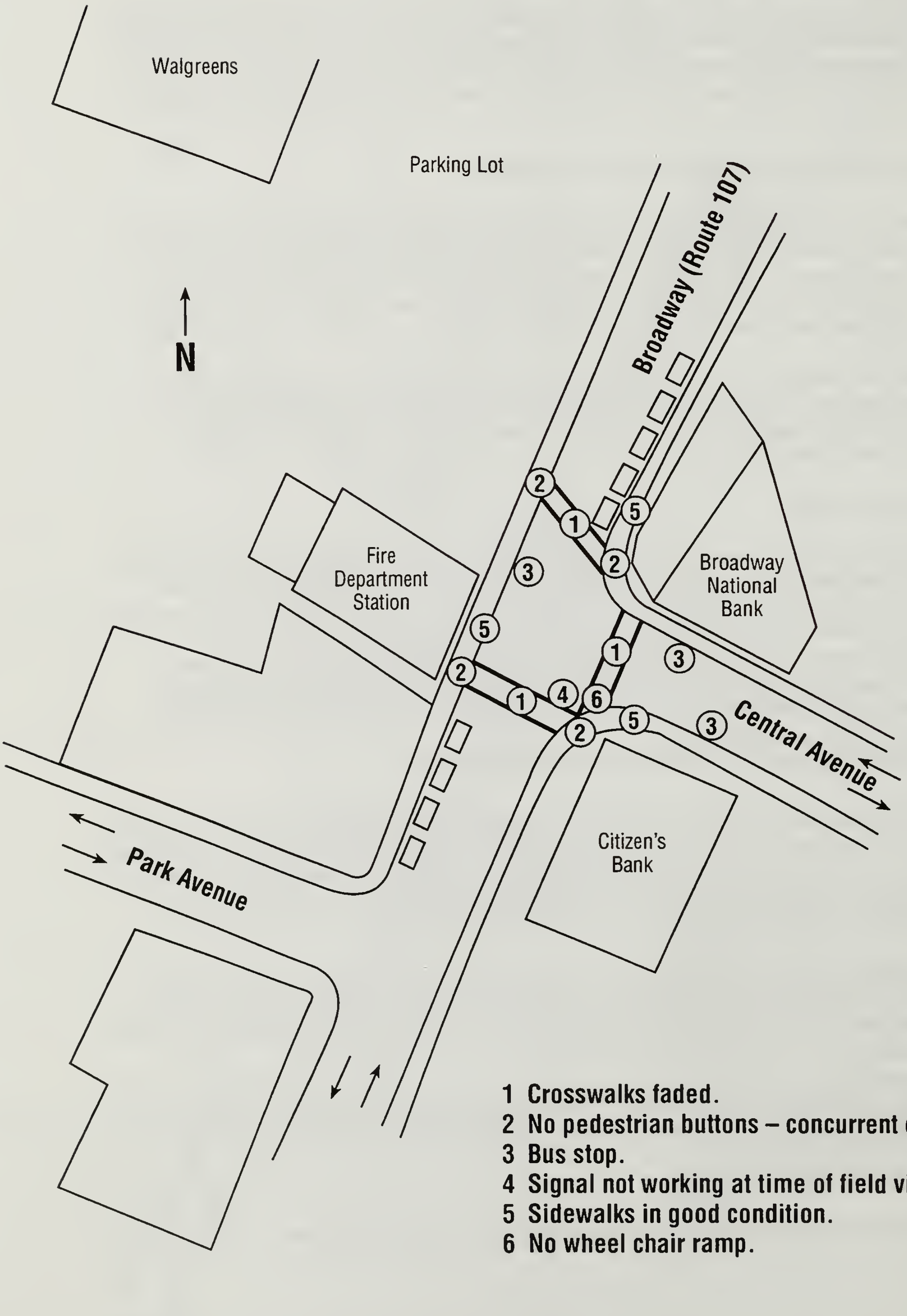
Most of the people parking at Wonderland are coming from the north and east. There are two major reasons. First, most of the commuter rail park-and-ride lots to the north get filled, except for the Lynn garage, which is grossly underutilized. Second, alternatives to the Blue Line, which offers fast and frequent service, are deemed inferior.

While the numbers were smaller, many people parking at Wonderland originate along the Route 1/Route 60 corridor in Saugus, Peabody, Danvers, and communities further north.

Proposed Improvements

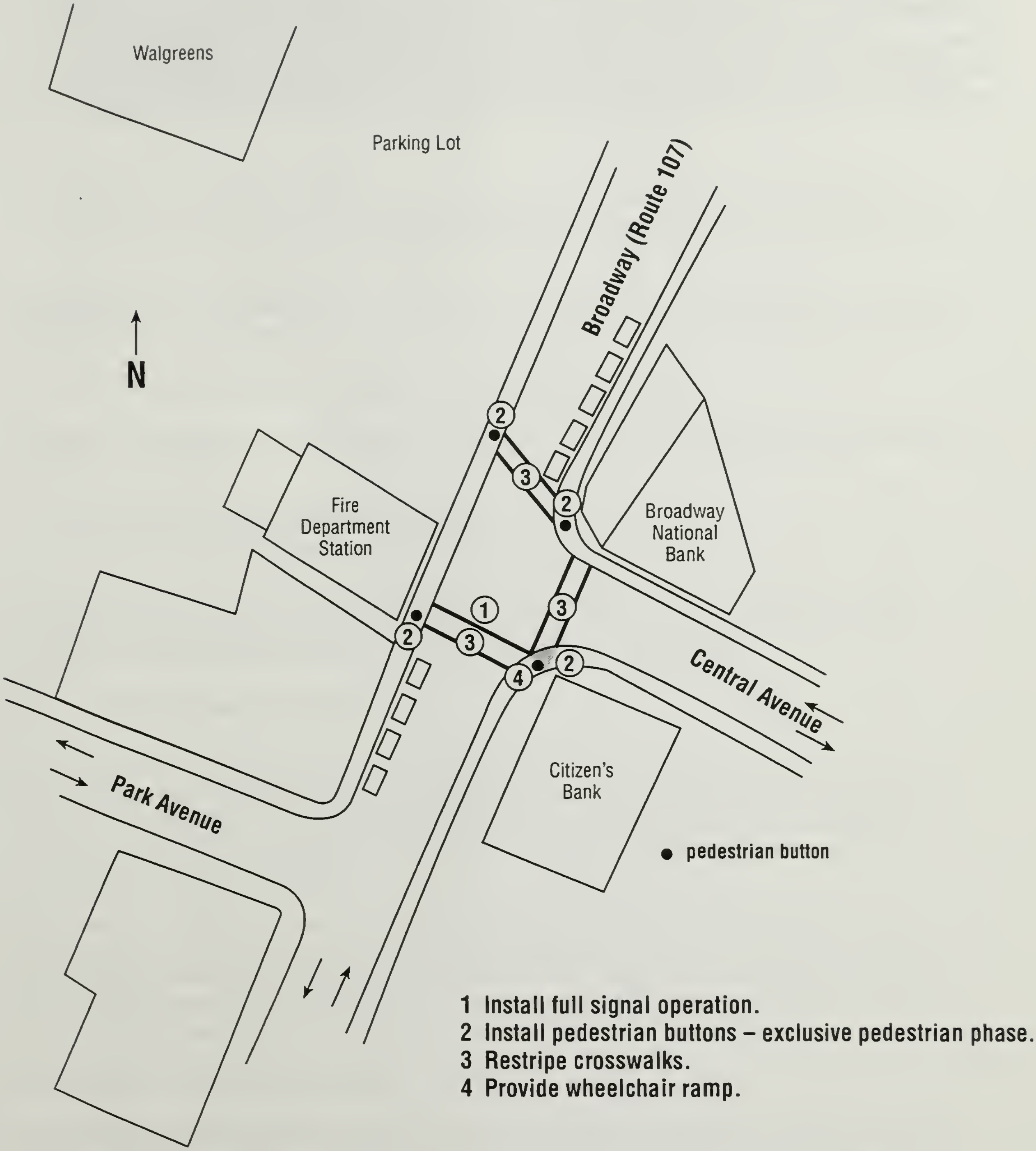
Four strategies were proposed for alleviating parking pressures at Wonderland:

Figure 3-29
Existing Conditions Related to Pedestrian Safety
Broadway @ Central Avenue, Revere



1 Crosswalks faded.
2 No pedestrian buttons – concurrent operations not working.
3 Bus stop.
4 Signal not working at time of field visit.
5 Sidewalks in good condition.
6 No wheel chair ramp.

Figure 3-30
Proposed Pedestrian Safety Improvements
Broadway @ Central Avenue, Revere



(1) Increase usage at the Lynn garage
(2) Improve existing express bus service from lower North Shore communities
(3) Establish new remote parking lots in Danvers, Peabody, Lynn, Lynnfield, and/or Saugus, whence many of the Blue Line riders are originating
(4) Extend the Blue Line to Lynn and possibly Beverly

In addition, the MBTA is studying two alternatives that focus on improved service to and from Wonderland Station. The two alternatives are an express bus service to Wonderland from the Lynn garage and the Wonderland Connector linking the commuter rail and the Blue Line. It should be noted that the Blue Line Extension and the Wonderland Connector are actually long-term improvement alternatives and that they could have farther-reaching ridership impacts.

4 LONG-RANGE ALTERNATIVES

This chapter describes improvement alternatives that involve major reconstruction and would require a long planning and design process. As discussed in chapter 2, regional traffic traveling between Route 1 north (North Shore area) and Route 1A south (Logan Airport, Boston) currently must go through the center of Revere, using Route 60 and Route 1A, due to the lack of appropriate connections between Route 1 and Route 1A via Route 16. To redirect this regional traffic away from the center of the city, CTPS proposed new and improved connections along the major limited-access roadways (Routes 1, 1A, and 16) at three locations:

- Route 1/Route 16 interchange
- A new connection between Route 1A and Route 16, including modifications to Route 145
- Route 1 between Copeland Circle (Route 60) and Route 99, focusing on improvements to the Lynn Street/Salem Street interchange

In addition, CTPS proposed a new connection to improve the flow of truck traffic between Logan Airport/Boston and Chelsea:

- A new connection between Route 1A and the Chelsea Street bridge

Finally, CTPS explored potential improvements at two locations along Route 60 to improve traffic conditions in Revere:

- Brown Circle (Route 60/Route 107 junction)
- Route 60 corridor between Brown Circle and Copeland Circle

The advantages and disadvantages of alternatives considered at each location are discussed, along with cost estimations. Information on traffic volume forecasts and expected levels of service at major signalized intersections are presented in the next chapter.

4.1 Route 1/Route 16 Interchange

The present interchange lacks connections between Route 16 to the east and Route 1 to the north. All traffic to and from Route 1 north and destinations such as Revere Beach and Logan Airport must use Copeland Circle and Squire Road (Route 60). New connections at Route 1/Route 16 provide the first of two necessary connections between Route 1 and Route 1A to give motorists an alternative to using Route 60.

The first and third alternatives considered were presented as concepts in the Mahoney Circle (Bell Circle) Grade Separation Feasibility Study completed in June 1997. Two other alternatives were also presented in the feasibility study report, but were rejected because they physically encroached upon already built structures or environmentally sensitive areas. Figures 4-1 to 4-5 show five alternatives that CTPS evaluated in this study.

Alternative 1: Two New Traffic Signal

This alternative introduces two new traffic signals on Route 16 with median breaks to allow for left turns from Route 16 westbound to Route 1 northbound and from Route 1 southbound to Route 16 eastbound (Figure 4-1). The primary disadvantage of this alternative is that two new signals on Route 16 would introduce delays for motorists on this road. According to the Chelsea

Department of Planning and Community Development, Chelsea hopes to redevelop the area directly east of the interchange, south of Route 16. If this happens, it could require an additional signal along Route 16 to access this site.

Alternative 2: Small-Radius Ramp Northbound

This alternative introduces a traffic signal on Route 16 with a median break to allow for left turns from Route 1 southbound to Route 16 eastbound. However, the movement from Route 16 westbound to Route 1 northbound is not accommodated by a traffic signal with a left-turn lane, but is instead accommodated by a right-hand, small-radius ramp (Figure 4-2). This ramp just misses the Prime Time Restaurant. There was some concern about the tightness of the ramp, which has a 175-foot radius, and the potentially significant impacts to traffic operations and safety on Route 16 as motorists slow down in advance of the off-ramp to negotiate the turn. This led to a revision of Alternative 2.

Alternative 2 Revised: Normal-Radius Ramp Northbound

The southbound off-ramp from Route 1 remains the same as in Alternative 2, but the northbound on-ramp to Route 1 now has a more operationally normal curve; it goes through the center of the restaurant property. This alternative should relieve the traffic and safety concerns, at the expense of more costly land takings and possibly more noise impacts for the adjacent condominiums (Figure 4-3).

Alternative 3: the Southbound Traffic Signal Alternative

This alternative eliminates the traffic signal in Alternative 1 that allows left turns from Route 16 westbound to Route 1 northbound. Instead, this move is accommodated by reconfiguring the loop ramp from Route 16 westbound to Route 1 southbound so that it goes under the elevated section of Route 1 and runs parallel between the northbound lanes of Route 1 and Fenno Street until it merges with Route 1 northbound (Figure 4-4). The "lost" move from Route 16 westbound to Route 1 southbound is not really lost because there is another on-ramp only a short distance downstream just past Webster Street. Concern has been expressed over the loss of the connection between Route 16 westbound and Route 1 southbound, because the North Shore MBTA buses heading into Boston tend to use this route to get to the Tobin Bridge when there are traffic delays at the Sumner Tunnel. The primary advantages of Alternative 3 are that it eliminates one of the two traffic signals in Alternative 1, reduces delay impacts on Route 16 traffic, and does not impact the Prime Time restaurant.

Preliminary 2020 forecasts from CTPS's 24-hour regional travel demand model indicate that, if either Alternative 1 or 2 is built, about 2,000 vehicles will use the new ramp connections during the AM or PM peak hour. This means that under Alternative 1, 2,000 vehicles will want to make the left turn from Route 1 southbound to Route 16 eastbound in the AM peak hour, and 2,000 vehicles will want to make the left turn from Route 16 westbound to Route 1 northbound in the PM peak hour. Multiple left-turn lanes will likely be required to satisfy this demand.

There seems to be insufficient space in the existing layout of Route 16 to accommodate two left-turn lanes. Without two lanes, long queues would be expected on Route 16 westbound heading to Route 1 northbound. For this reason, Alternatives 2 and 3, concepts that eliminate one of the two traffic signals and provide an exclusive, uninterrupted ramp connection between Route 16 westbound and Route 1 northbound, appear to be better candidates at this time due to the additional capacity provided by the modified ramp.
Figure 1, Routes 1/16, Alternative 1

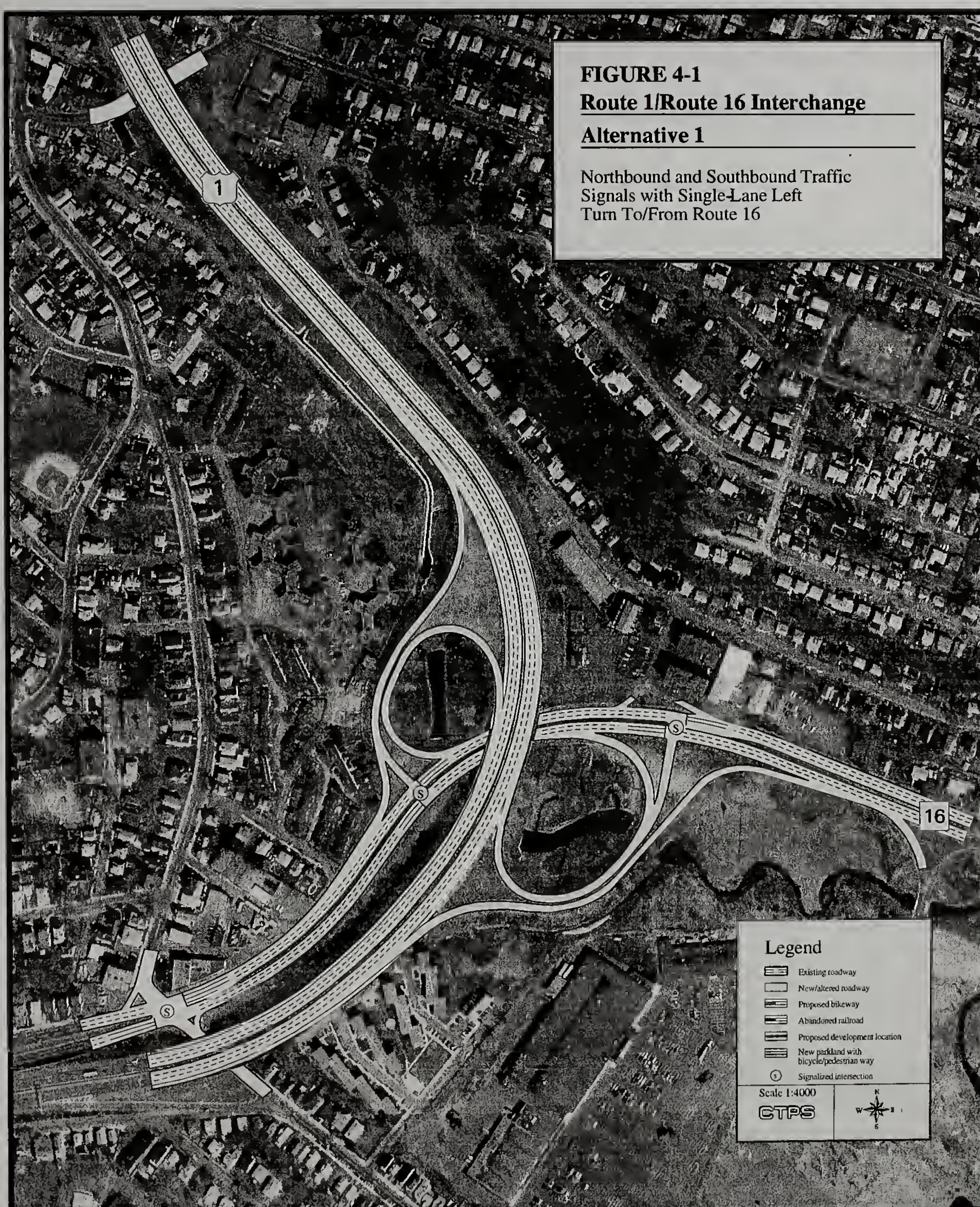


FIGURE 4-1
Route 1/Route 16 Interchange
Alternative 1

Northbound and Southbound Traffic Signals with Single-Lane Left Turn To/From Route 16

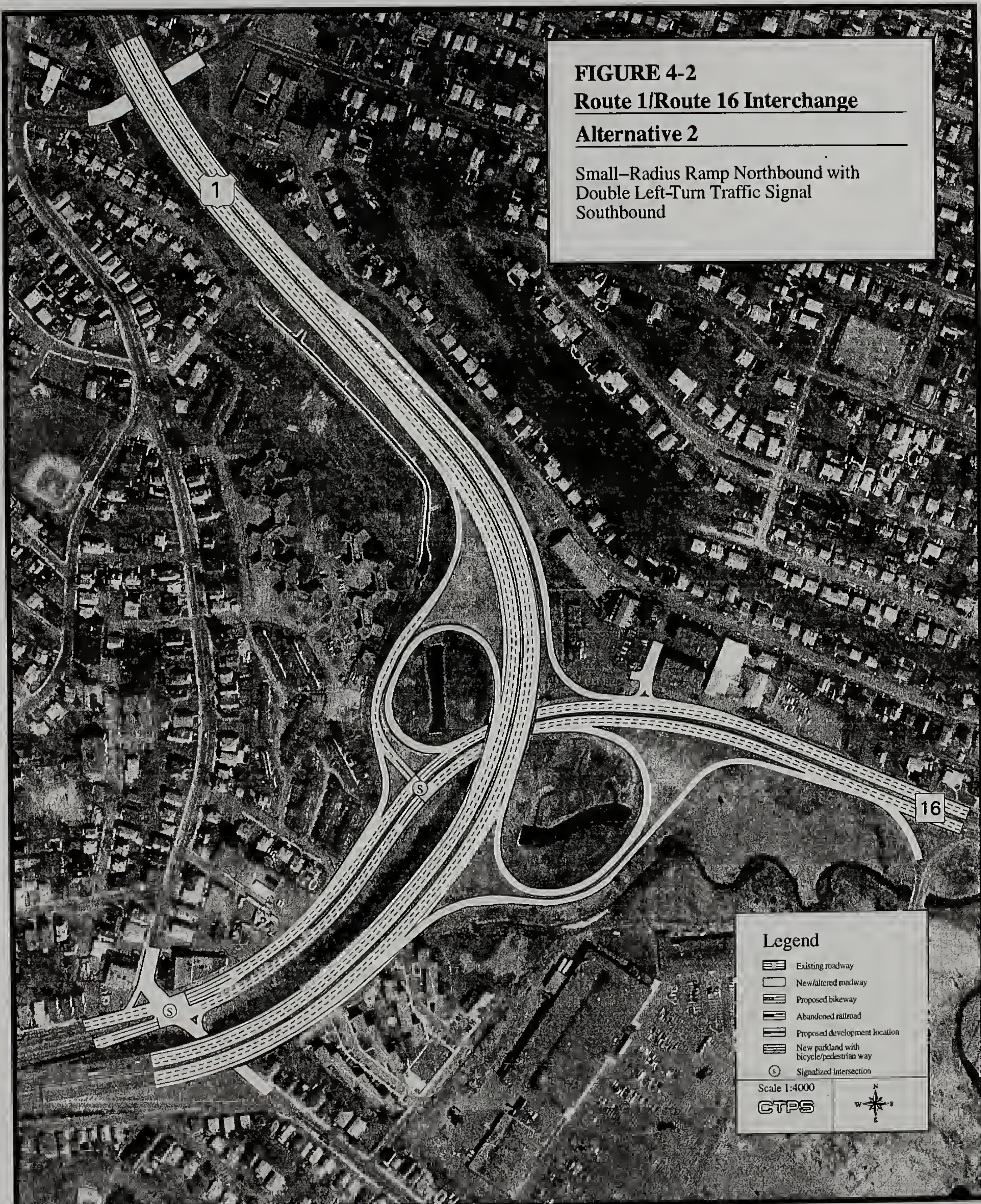


FIGURE 4-2
Route 1/Route 16 Interchange
Alternative 2

Small–Radius Ramp Northbound with Double Left-Turn Traffic Signal Southbound

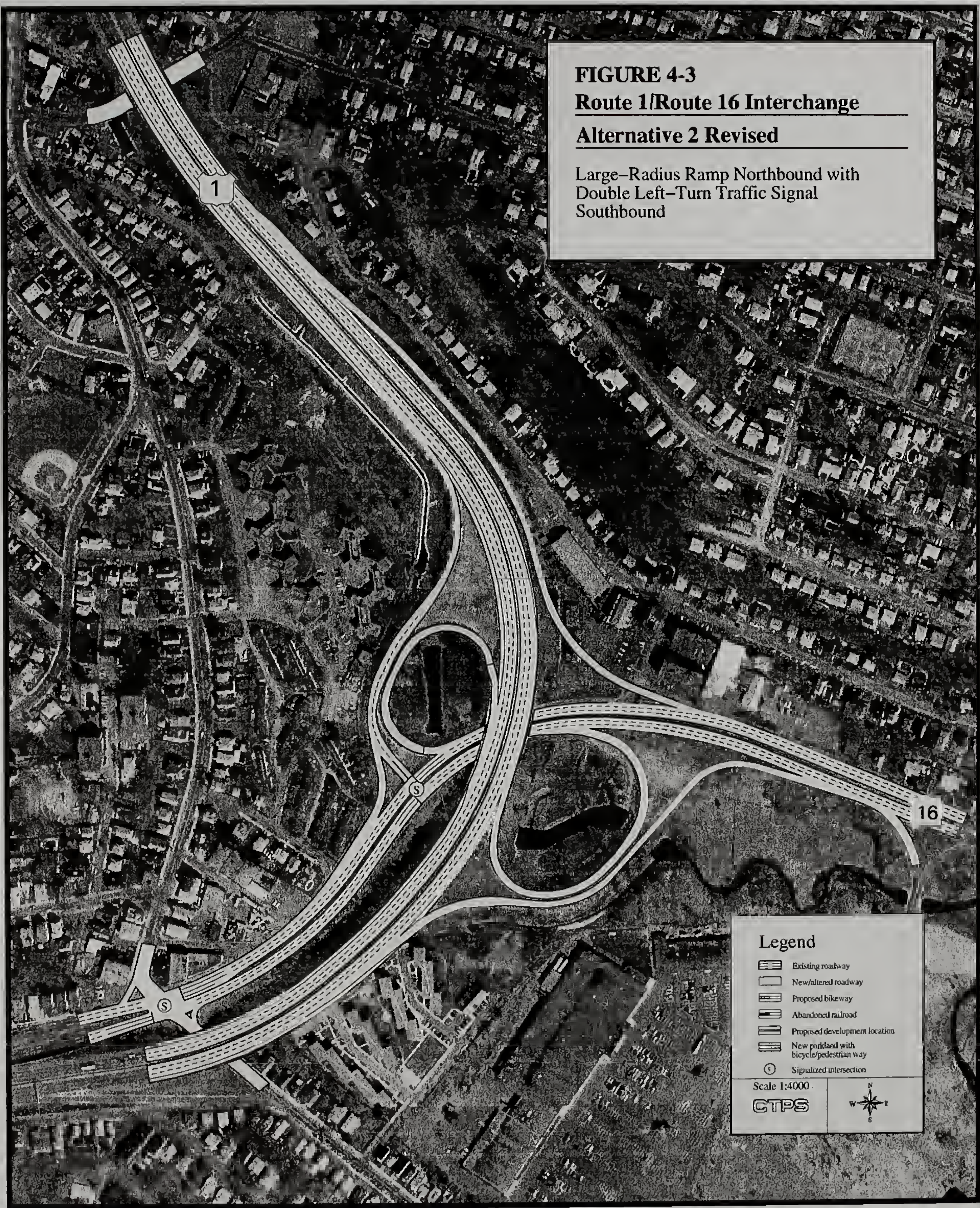


FIGURE 4-3
Route 1/Route 16 Interchange
Alternative 2 Revised

Large–Radius Ramp Northbound with Double Left–Turn Traffic Signal Southbound

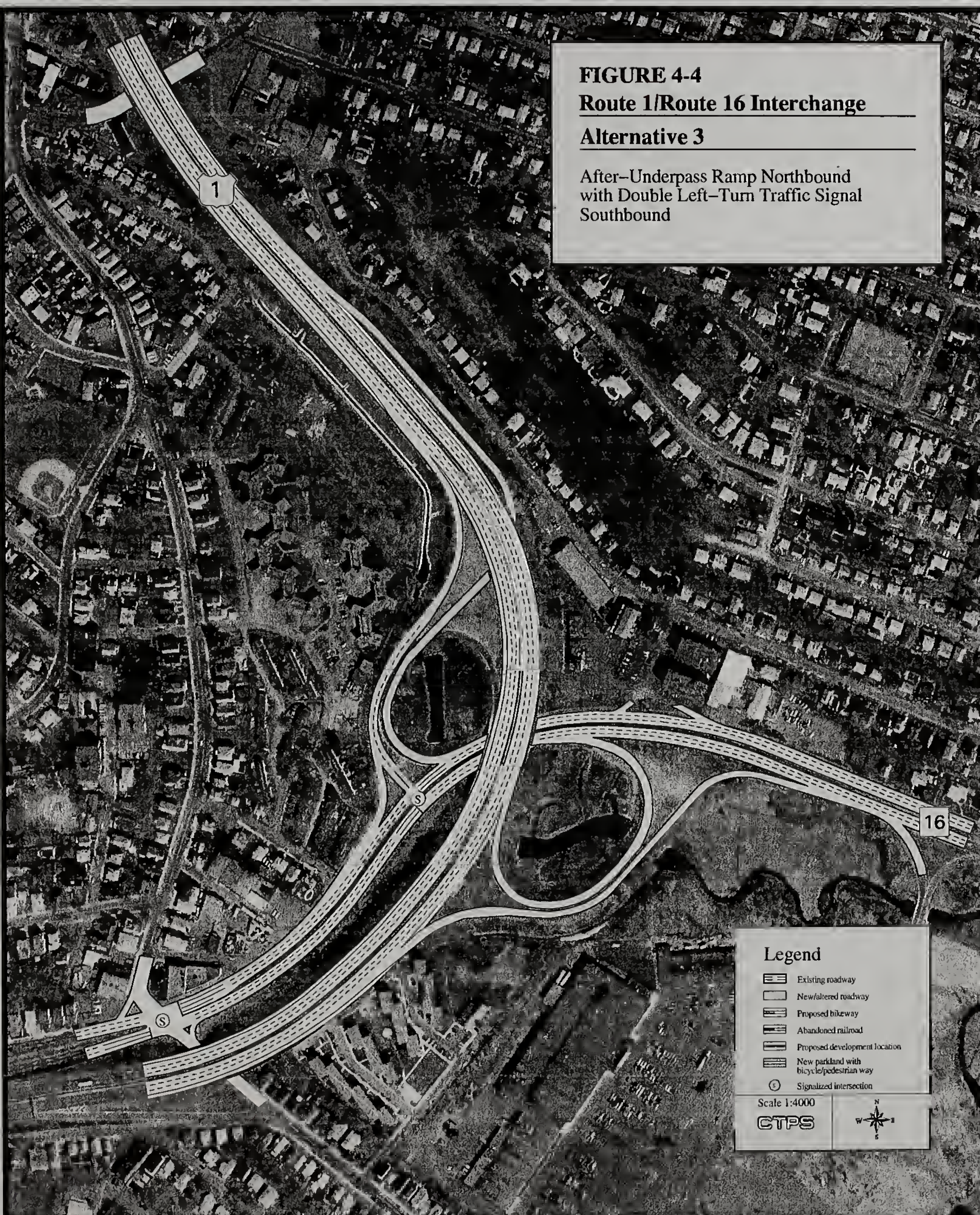


FIGURE 4-4
Route 1/Route 16 Interchange
Alternative 3

After–Underpass Ramp Northbound with Double Left–Turn Traffic Signal Southbound

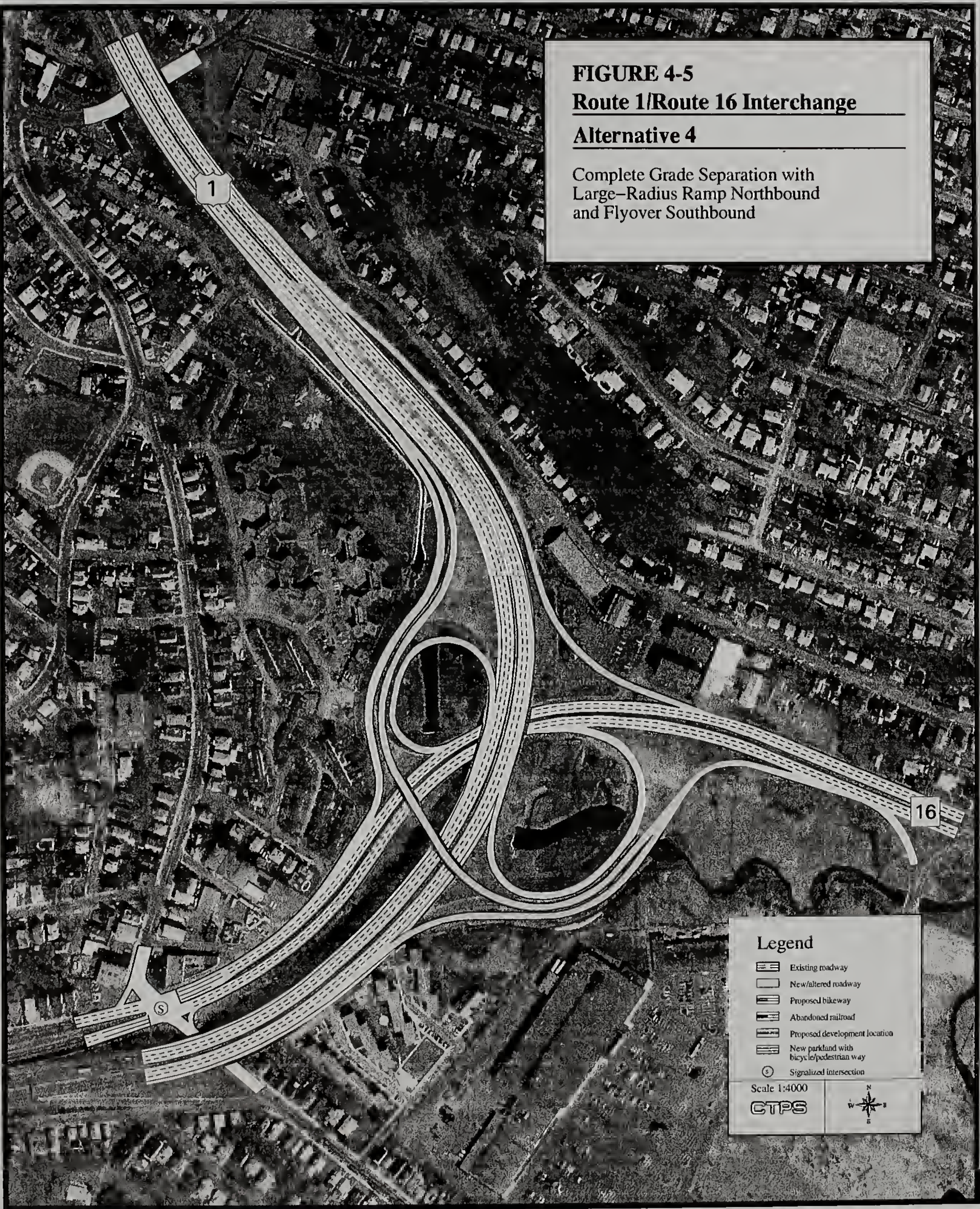


FIGURE 4-5
Route 1/Route 16 Interchange
Alternative 4

Complete Grade Separation with Large–Radius Ramp Northbound and Flyover Southbound

Alternative 4: Complete Grade Separation with Large-Radius Ramp Northbound

This alternative grade-separates all movements with a large-radius ramp from Route 16 westbound to Route 1 northbound that bisects the restaurant and a flyover from Route 1 southbound to Route 16 eastbound. It seems to be the case that if the restaurant were taken, there would be enough space available to meet current design standards (Figure 4-5). However, this is the most expensive alternative, costing more than three times as much as Alternative 2.

Cost Estimations

The estimated total costs of the Route 1/Route 16 interchange alternatives are given below. Tables 4-1 to 4-5 summarize the estimated costs of major components of each alternative.

- Alternative 1 — Add signal and single left-turn lane for both NB and SB Route 1 moves. Estimated total cost: $1.7 million.
- Alternative 2 — Provide signal and double left-turn for Route 1 SB. Build ramp curving behind the restaurant between Route 16 WB and Route 1 NB. Estimated total cost: $4.1 million.
- Alternative 2 Revised — Same as Alternative 2, except straighten ramp to Route 1 NB. Estimated total cost: $3.9 million (not including taking costs).
- Alternative 3 — Provide signal and double left-turn lane for Route 1 SB. Build new ramp from Route 16 WB to Route 1 NB, under Route 1; existing ramp from Routes 16 WB to Route 1 SB is removed. Estimated total cost: $7.3 million.
- Alternative 4 — Build flyover for Route 1 SB–to–Route 16 EB move. Build ramp for Route 16 WB–to–Route 1 NB move from Alternative 2 Revised (see above). Estimated total cost: $13.1 million.

Table 4-1
Construction Cost Estimate for Route 1/Route 16 Interchange Alternative 1

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 16 WB to Route 1 NB Connector					
New EB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	$375	600	$225,000
New WB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	375	600	225,000
Ramp connection to Route 1 NB on-ramp	22 ft. roadway at-grade	Linear foot	300	300	90,000
New signalized intersection	Traffic signals	Intersection	75,000	1	75,000
				Subtotal	**$615,000**
Route 1 SB to Route 16 EB Connector					
New EB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	$375	600	$225,000
New WB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	375	600	225,000
New one-lane ramp from Route 1 SB to signal	22 ft. roadway at-grade	Linear foot	300	200	60,000
New signalized intersection	Traffic signals	Intersection	75,000	1	75,000
				Subtotal	**$585,000**
				Combined Total	**$1,200,000**
				Signage, pavement markings, and landscaping (10%)	$120,000
				Traffic management during construction (10%)	$120,000
				Subtotal	**$1,440,000**
				Contingencies (15%)	$216,000
				Grand Total	**$1,656,000**

Table 4-2
Construction Cost Estimate for Route 1/Route 16 Interchange Alternative 2

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 16 WB to Route 1 NB Connector					
Route 1 retaining wall	25 ft. retaining wall	Linear foot	1,200	600	720,000
Route 1 embankment removal	Earth excavation	Cubic yard	6	40,000	240,000
New roadway from Route 16 WB to Route 1 NB	22 ft. roadway at-grade	Linear foot	300	2,300	690,000
				Subtotal	**$1,650,000**
Route 1 SB to Route 16 EB Connector					
New EB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	375	600	225,000
New WB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	375	600	225,000
New signalized intersection	Traffic signals	Intersection	75,000	1	75,000
New two-lane ramp from Route 1 SB to signal	36 ft. roadway on embankment	Linear foot	750	800	600,000
Relocated ramp from Route 16 WB to Route 1 SB	22 ft. roadway at-grade	Linear foot	300	700	210,000
				Subtotal	**$1,335,000**
				Combined Total	**$2,985,000**
				Signage, pavement markings and landscaping (10%)	$299,000
				Traffic management during construction	$299,000
				Subtotal	**$3,583,000**
				Contingencies (15%)	$537,450
				Grand Total	**$4,120,450**

Table 4-3

Construction Cost Estimate for Route 1/Route 16 Interchange Alternative 2 Revised[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 16 WB to Route 1 NB Connector					
Route 1 retaining wall	25 ft. retaining wall	Linear foot	$1,200	500	$600,000
Route 1 embankment removal	Earth excavation	Cubic yard	6	33,333	200,000
New roadway from Route 16 WB to Route 1 NB	22 ft. roadway at-grade	Linear foot	300	2,200	660,000
				Subtotal	**$1,460,000**
Route 1 SB to Route 16 EB Connector					
New EB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	$375	600	$225,000
New WB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	375	600	225,000
New signalized intersection	Traffic signals	Intersection	75,000	1	75,000
New two-lane ramp from Route 1 SB to signal	36 ft. roadway on embankment	Linear foot	750	800	600,000
Relocated ramp from Route 16 WB to Route 1 SB	22 ft. roadway at-grade	Linear foot	300	700	218,000
				Subtotal	**$1,335,000**
				Combined Total	**$2,795,000**
				Signage, pavement markings and landscaping (10%)	$279,500
				Traffic management during construction (10%)	$279,500
				Subtotal	**$3,354,000**
				Contingencies (15%)	$503,100
				Grand Total	**$3,857,100**

[1]Not including cost of taking Prime Time restaurant.

Table 4-4
Construction Cost Estimate for Route 1/Route 16 Interchange Alternative 3

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 16 WB to Route 1 NB Connector					
New ramp from Route 16 to new underpass	Equivalent to 22 ft. roadway on embankment	Linear foot	$625	750	$468,750
Retaining walls for new Route 1 bridge	25 ft. retaining wall	Linear foot	1,200	500	600,000
Route 1 embankment removal	Earth excavation	Cubic yard	6	50,000	300,000
New Route 1 viaduct	Six lane viaduct	Square foot	200[1]	7,000	1,400,000
Route 1 Detour routing during staging					1,000,000
New ramp under underpass	22 ft. roadway at-grade	Linear foot	300	175	52,500
New ramp from underpass to Route 1 NB	22 ft. roadway at-grade	Linear foot	300	1,200	360,000
				Subtotal	**$4,181,250**
Route 1 SB to Route 16 EB Connector					
New EB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	$375	600	$225,000
New WB roadway with correct superelevation	36 ft. roadway at-grade	Linear foot	375	600	225,000
New signalized intersection	Traffic signals	Intersection	75,000	1	75,000
New two-lane ramp from Route 1 SB to signal	36 ft. roadway on embankment	Linear foot	750	800	600,000
				Subtotal	**$1,125,000**
				Combined Total	**$5,306,250**
				Signage, pavement markings and landscaping (10%)	$530,625
				Traffic management during construction(10%)	$530,625
				Subtotal	**$6,367,500**
				Contingencies (15%)	$955,125
				Grand Total	**$7,322,625**

[1]Assumes staged construction.

Table 4-5
Construction Cost Estimate for Route 1/Route 16 Interchange Alternative 4[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 16 WB to Route 1 NB Connector					
Route 1 retaining wall	25 ft. retaining wall	Linear foot	$1,200	500	$600,000
Route 1 embankment removal	Earth excavation	Cubic yard	6	33,333	200,000
New roadway from Route 16 WB to Route 1 NB	22' ft. roadway at-grade	Linear foot	300	2,200	660,000
				Subtotal	**$1,460,000**
Route 1 SB to Route 16 EB Connector					
First segment: one lane ramp on embankment	22 ft. roadway on embankment	Linear foot	$625	1,600	$1,000,000
Second segment: one lane ramp on structure	One lane viaduct	Linear foot	4,500	1,200	5,400,000
Third segment: one lane ramp on embankment	22 ft. roadway on embankment	Linear foot	625	200	125,000
Fourth segment: two lane ramp at-grade	36 ft. roadway at-grade	Linear foot	375	400	150,000
				Subtotal	**$6,675,000**
Relocated Ramps					
Relocated ramp from Route 1 SB to Route 16 WB	22 ft. roadway on embankment	Linear foot	$625	600	$375,000
Relocated ramp from Route 16 WB to Route 1 SB	22 ft. roadway on embankment	Linear foot	625	800	500,000
Relocated ramp from Route 1 NB to Route 16 EB	22 ft. roadway on embankment	Linear foot	625	800	500,000
				Subtotal	**$1,375,000**
				Combined Total	**$9,510,000**
				Signage, pavement markings and landscaping (10%)	$951,000
				Traffic management during construction (10%)	$951,000
				Subtotal	**$11,412,000**
				Contingencies (15%)	$1,711,800
				Grand Total	**$13,123,800**

[1]Not including cost of taking Prime Time restaurant.

4.2 New Route 1A and Route 16 Connections

Once Route 1 and Route 16 are connected, Route 1A and Route 16 must also have seamless connections to complete the full Routes 1/16/1A connection. Recent developments along the Route 1A corridor between Mahoney Circle and Boardman Street, including proposals for two new hotels, a waste transfer facility, and the redevelopment of Suffolk Downs, indicate the need for a more comprehensive plan for the corridor. It was expected that this study could be a step toward for a coordinated, regionwide effort.

Variations on several of these alternatives were presented as concepts in the Mahoney Circle Grade Separation Feasibility Study completed in June 1997.

Alternative 1: Minimum-Build Providing for Left Turns

This minimum-build alternative provides two signalized median breaks on Route 145/Revere Beach Parkway to allow for left turns from Route 1A northbound to Revere Beach Parkway westbound and from Revere Beach Parkway westbound to Route 1A southbound. The interchange of Route 1A and Route 145/Revere Beach Parkway currently provides only for unsignalized left turns from Revere Beach Parkway westbound to Route 1A southbound. In this alternative, continuous access along Winthrop Avenue/Revere Beach Parkway is maintained (Figure 4-6). The Revere Beach Parkway bridge over the Rockport Line was identified as having a three-ton truck limit; therefore CTPS recommends replacing the bridge.

Alternative 2: Flyover Alternative

The second alternative provides direct connections via flyovers between Route 1A northbound and Route 16 westbound, and the reverse, Route 16 eastbound to Route 1A southbound. The design shown is just south of Railroad Avenue and travels between the proposed Hampton Inn and waste transfer station sites (Figure 4-7). When combined with other proposed improvements at Route 1 and Route 16, this alternative would provide a direct, unsignalized connection between Logan Airport and the tunnels and Route 1 to the north. It would not provide access in other directions and would not allow for access to the northern end of Suffolk Downs. Some elevated structures would be required on the Route 16 end near some residential neighborhoods.

Alternative 3: Diamond Interchange with Direct Connection to Revere Beach Parkway

This alternative provides a diamond interchange directly adjacent to Suffolk Downs. Route 1A is realigned to the west, as in Alternative 2. Route 16/Revere Beach Parkway, west of Route 1A, is realigned to the south and grade-separated over the railroad. Through traffic on Revere Beach Parkway east of Route 1A, however, is interrupted because Revere Beach Parkway now travels through the Suffolk Downs site. The slip ramps at the diamond interchange might impact the existing oil storage infrastructure. In this alternative, continuous access along Winthrop Ave/Revere Beach Parkway is maintained, while a new six-lane roadway is introduced through the Suffolk Downs parcel with a grade-separated interchange at Route 1A. Figure 4-8 shows the alternative.

Alternative 4: Partial Cloverleaf Alternative

This alternative realigns Route 16/Revere Beach Parkway and Route 1A and places at the junction a partial ¾ cloverleaf interchange serving all movements. One new traffic signal is introduced on Route 16/Revere Beach Parkway, providing for left turns between Route 1A southbound and Route 16 eastbound. Earlier versions of this alternative ended under Route 1A, but the city of Revere objected to the potential division of neighborhoods. A partial cloverleaf

with two signals was also considered, but the signalized left turns under the option operated no better than under the diamond interchange alternative. Figure 4-9 shows the proposed partial cloverleaf alternative.

Cost Estimations

The estimated costs of the Route 1A/Route 16 interchange alternatives are summarized below:

- Alternative 1 — Add new signalized left turns at Routes 1A/145. Cost included as part of the Mahoney Circle project.
- Alternative 2 — Build two flyover ramps, Route 16 EB to Route 1A SB and Route 1A NB to Route 16 WB. Otherwise, identical to Alternative 1 (see above). Estimated total cost: $14.4 million (Table 4-6).
- Alternative 3 — Provide direct connection between Route 1A and Route 16 at existing Suffolk Downs entrance. All moves between Routes 1A and 16 handled at two signalized diamond intersection. Route 16 extended to intersect with Route 145 at Winthrop Avenue, and current Route 145 downgraded to a local street. Estimated total cost: $27.1 million (Table 4-7).
- Alternative 4 — Build partial ¾ cloverleaf interchange serving all movements, including one new traffic signal providing for left turns between Route 1A SB and Route 16 EB. Estimated total cost: $39.6 million (Table 4-8).

FIGURE 4-6

Route 1A and Route 16 Connections

Alternative 1

New Left Turns and Signals
At Existing Route 1A/Route 145 Interchange

Also shown:
Mahoney Circle Alternative 3
Six–lane 1A

FIGURE 4-7
Route 1A and Route 16 Connections
Alternative 2

New Route 1A/Route 16 Flyover Interchange Plus Alternative 1

Also shown:
Mahoney Circle Alternative 3
Six–lane Route 1A

FIGURE 4-8

Route 1A and Route 16 Connections Alternative 3

New Route 1A/Route 16 Diamond Interchange with Route 16/Revere Beach Connector

Also shown:
Mahoney Circle Alternative 3
Suffolk Downs southwest entry grade separation
Boardman Street grade separation
Six–lane Route 1 A

FIGURE 4-9
Route 1A and Route 16 Connections
Alternative 4

3/4 Cloverleaf at Route 1A
with Route 16/Revere Beach Connector

Also shown:
Mahoney Circle Alternative 3
Suffolk Downs southwest entry grade separation
Boardman Street grade separation
Six–lane Route 1A

Table 4-6
Construction Cost Estimate for Route 1A/Route 16 Alternative 2

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1A Mainline Reconstruction					
Southerly project limit to WB flyover diverge	Six lanes at-grade,102' wide	linear foot	825	300	247,500
WB flyover diverge to EB flyover merge	Five lanes at-grade,90' wide	linear foot	800	900	720,000
EB flyover merge to northerly project limit	Four lanes at-grade,78' wide	linear foot	750	300	225,000
Subtotal					$1,192,500
Westbound Flyover					
Grade to first viaduct section	One-lane embankment, 22' wide	linear foot	625	900	562,500
First viaduct section	One-lane viaduct	linear foot	4,500	250	1,125,000
First viaduct section to second viaduct section	One-lane embankment, 22' wide	linear foot	625	850	531,250
Northerly retaining wall	Retaining wall, 25' high	linear foot	1,200	850	1,020,000
Second viaduct section	One-lane viaduct	linear foot	4,500	350	1,575,000
Second viaduct section to grade	One-lane embankment, 22' wide	linear foot	625	600	375,000
Northwesterly retaining wall	Retaining wall, average 15' high		600	600	360,000
Southeasterly retaining wall	Retaining wall, average 15' high	linear foot	600	600	360,000
Grade to westerly project limit	44' roadway at-grade	linear foot	400	300	120,000
Subtotal					$6,028,750
Eastbound Flyover					
Westerly project limit to flyover diverge	44' roadway at-grade	linear foot	400	300	120,000
Grade to viaduct section	One-lane embankment, 22' wide	linear foot	625	600	375,000
Northwesterly retaining wall	Retaining wall, average 15' high	linear foot	600	600	360,000
Viaduct section	One-lane viaduct	linear foot	4,500	250	1,125,000
Viaduct section to Route 1A merge	One-lane embankment, 22' wide	linear foot	625	1,050	656,250
Subtotal					$2,636,250
Eastbound Route 16 Reconstruction					
Flyover diverge to northerly project limit	36' roadway at-grade	linear foot	375	1,200	450,000
Subtotal					$450,000
Westbound Route 16 Reconstruction					
Northerly project limit to westbound flyover merge	36' roadway at-grade	linear foot	375	300	112,500
Subtotal					$112,500
Combined Total					$10,420,000

Table 4-6 (Cont'd)
Construction Cost Estimate for Route 1A/Route 16 Alternative 2

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
	Signage, pavement markings and landscaping (10%)				$1,042,000
	Traffic management (10%)				$1,042,000
				Subtotal	$12,504,000
	Contingencies (15%)				$1,875,600
				Grand Total	$14,379,600

Table 4-7

Construction Cost Estimate for Route 1A/Route 16 Alternative 3[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1A Mainline NB & SB Combined					
S. project limit to Rte. 16 NB ramp diverge, SB merge	Six lanes at-grade, 102' wide	linear foot	825	250	206,250
S. ramps diverge/merge to Rte. 16/Rte. 145 viaduct	Four lane embankment, 78' wide	linear foot	1,250	450	562,500
Retaining walls S. of Rte. 16/Rte. 145	Two 350' retaining walls, average 15' high	linear foot	600	700	420,000
Viaduct over Rte. 16/Rte. 145	Four-lane viaduct	linear foot	11,500	250	2,875,000
Rte. 16/Rte. 145 viaduct to N. ramps merge/diverge	Four-lane roadway on embankment, 78' wide	linear foot	1,250	550	687,500
Ramps merge/diverge to existing Rte. 145 viaduct	Four-lane roadway on embankment, 92' wide	linear foot	1,300	350	455,000
Subtotal					$5,206,250
Route 1A Ramps to/from Route 16/Route 145					
Rte. 1A NB off-ramp: segment 1	Two-lane roadway at-grade, 36' wide	linear foot	375	300	112,500
Rte. 1A NB off-ramp: segment 2	Three-lane roadway at-grade, 44' wide	linear foot	400	250	100,000
Rte. 1A NB on-ramp: segment 1	36' roadway at-grade	linear foot	375	250	93,750
Rte. 1A NB on-ramp: segment 2	22' roadway on embankment	linear foot	625	350	218,750
Rte. 1A SB off-ramp: segment 1	22' roadway on embankment	linear foot	625	350	218,750
Rte. 1A SB off-ramp: segment 2	36' roadway at-grade	linear foot	375	250	93,750
Rte. 1A SB on-ramp	One lane at-grade, 22' wide	linear foot	300	600	180,000
Subtotal					$1,017,500
Route 16/Route 145 EB					
W. project limit to beginning of upgrade	36' roadway at-grade	linear foot	375	300	112,500
Beginning of up-grade to railroad viaduct	36' roadway on embankment	linear foot	750	450	337,500
Viaduct over railroad & bikeway	Three-lane viaduct	linear foot	10,000	200	2,000,000
Railroad viaduct to grade	36' roadway on embankment	linear foot	750	800	600,000
End of embankment through Rte. 1A intersections	44' roadway at-grade	linear foot	400	650	260,000
Rte. 1A intersections to Suffolk Downs intersection approach	36' roadway at-grade	linear foot	375	1,600	600,000
Intersection approach through Suffolk Downs intersection	44' roadway at-grade	linear foot	400	450	180,000

[1]Does not include costs of bikeway/pedestrianway/linear park facilities.

Table 4-7 (Cont'd)
Construction Cost Estimate for Route 1A/Route 16 Alternative 3[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 16/Route 145 EB (Cont'd)					
Suffolk Downs intersection to R.B.P. intersection approach	36' roadway at-grade	linear foot	375	350	131,250
R.B.P. approach through R.B.P. intersection	44' roadway at-grade	linear foot	400	400	160,000
R.B.P. intersection to easterly project limit	36' roadway at-grade	linear foot	375	250	93,750
Subtotal					$4,475,000
Route 145/Route 16 WB					
E. project limit through R.B.P. intersection	44' roadway at-grade	linear foot	400	450	180,000
R.B.P. Intersection to Suffolk Downs intersection approach	36' roadway at-grade	linear foot	375	200	75,000
Suffolk Downs intersection approach through intersection	44' roadway at-grade	linear foot	400	400	160,000
Suffolk Downs intersection to Rte. 1A intersection approach	36' roadway on embankment	linear foot	375	1,700	637,500
Intersection approach through Rte. 1A intersections	44' roadway at-grade	linear foot	400	500	200,000
Rte. 1A intersections to beginning of grade	36' roadway on embankment	linear foot	375	400	150,000
Beginning of up-grade to viaduct	36' roadway on embankment	linear foot	750	750	562,500
Viaduct over railroad and bikeway	Three-lane viaduct	linear foot	10,000	200	2,000,000
Railroad/bikeway viaduct to grade	36' roadway on embankment	linear foot	750	500	375,000
Grade to westerly project limit	44' roadway at-grade	linear foot	400	300	120,000
Subtotal					$4,460,000
Revere Beach Parkway: Mill Street to Winthrop Avenue					
Segment 1: Mill Street to Vinal Street	22' roadway at-grade	linear foot	300	1,050	315,000
Segment 2: Vinal Street to Winthrop Avenue	44' roadway at-grade	linear foot	400	1,100	440,000
Subtotal					$755,000

[1]Does not include costs of bikeway/pedestrianway/linear park facilities.

Table 4-7 (Cont'd)

Construction Cost Estimate for Route 1A/Route 16 Alternative 3[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Revere Beach Parkway: Winthrop Avenue to Easterly Project Limit					
Winthrop Avenue intersection to railroad viaduct	44' roadway at-grade	per intersection	400	250	100,000
Railroad viaduct	Four lane viaduct	per intersection	11,500	100	1,150,000
Railroad viaduct to N. Shore Road intersection	44' roadway at-grade	linear foot	400	2,300	920,000
Local access roadway	22' roadway at-grade	linear foot	300	900	270,000
N. Shore Rd. intersection to New Rte. 145 intersection	Four lanes at-grade, 78' wide	linear foot	750	800	600,000
New Rte. 145 intersection to easterly project limit	Four lanes at-grade, 78' wide	linear foot	750	250	187,500
Subtotal					$3,227,500
Traffic Signals and Miscellaneous					
Signals at Rte. 1A/Rte. 16/Rte. 145 intersections	Traffic signals	per intersection	75,000	2	150,000
Signals at New Rte. 145/Suffolk Downs intersection	Traffic signals	per intersection	75,000	1	75,000
Signals at New Rte. 145/R.B.P. intersection	Traffic signals	per intersection	75,000	1	75,000
Signals at Winthrop Ave./Old Rte. 16 intersection	Traffic signals	per intersection	75,000	1	75,000
Signals at New R.B.P./N. Shore Road intersection	Traffic signals	per intersection	75,000	1	75,000
U-turn under Rte. 1A/Rte. 16/Rte. 145 viaduct	22' roadway at-grade	linear foot	300	150	45,000
Subtotal					$495,000
Combined Total					$19,636,250
Signage, pavement markings and landscaping (10%)					$1,963,625
Traffic management (10%)					$1,963,625
				Subtotal	$23,563,500
Contingencies (15%)					$3,534,525
				Grand Total	$27,098,025

[1]Does not include costs of bikeway/pedestrianway/linear park facilities.

Table 4-8

Construction Cost Estimate for Route 1A/Route 16 Alternative 4[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1A Mainline NB & SB Combined					
S. project limit to Rte. 16 EB ramp diverge	Six-lane roadway at grade	linear foot	825	350	288,750
Ramp diverge to Rte. 16/Rte. 145 viaduct	Six-lane embankment	linear foot	1,650	500	825,000
Retaining walls S. of Rte. 16/Rte. 145 viaduct	Two 350' retaining walls, average 15' high	linear foot	600	700	420,000
Viaduct over Rte. 16/Rte. 145	Six-lane viaduct	linear foot	18,500	200	3,700,000
Rte. 16/Rte. 145 viaduct to Old Rte. 145 viaduct	Six-lane embankment, 102' wide	linear foot	1,650	800	1,320,000
Retaining walls from Rte. 16/Rte.145 viaduct to Old Rte. 145 viaduct	Two 800' retaining walls, average 25' high	linear foot	1,000	1,600	1,600,000
Replacement viaduct over Old Rte. 145	Six-lane viaduct	linear foot	18,500	150	2,775,000
Replacement Old Rte. 145 viaduct to N. project limit	Six-lane roadway partially at grade	linear foot	1,200	300	360,000
Subtotal					$11,288,750
Route 1A Cloverleaf at Route 16/Route 145					
Frontage road NB from S. project limit to U-Turn	One-lane roadway at grade 22' wide	linear foot	300	830	249,000
U-turn from NB to SB frontage road	Two-lane roadway at grade 36' wide	linear foot	375	200	75,000
Frontage road SB from U-Turn to S. project limit	One-lane roadway at grade 22' wide	linear foot	300	830	249,000
Ramp from Rte. 1A NB to Rte. 145 EB	One-lane roadway at grade 22' wide	linear foot	300	1,000	300,000
Ramp from Rte. 145 EB to Rte. 1A NB Segment #1	One-lane roadway at grade 22' wide	linear foot	300	200	60,000
Ramp from Rte. 145 EB to Rte. 1A NB Segment #2	One-lane roadway on embankment	linear foot	625	550	343,750
Ramp from Rte. 145 EB to Rte. 1A NB Segment #3	One-lane viaduct	linear foot	4,500	100	450,000
Ramp from Rte. 1A NB to Rte. 145 WB Segment #1	One-lane roadway on embankment	linear foot	625	700	437,500
Ramp from Rte. 1A NB to Rte. 145 WB Segment #2	One-lane roadway at grade 22' wide	linear foot	300	200	60,000

[1] Does not include costs of bikeway/pedestrianway/linear park facilities.

Table 4-8 (Cont'd)

Construction Cost Estimate for Route 1A/Route 16 Alternative 4[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1A Cloverleaf at Route 16/Route 145 (Cont'd)					
Ramp from Rte. 145 WB to Rte. 1A NB Segment #1	One-lane roadway at grade 22' wide	linear foot	300	400	120,000
Ramp from Rte. 145 WB to Rte. 1A NB Segment #2	One-lane roadway on embankment	linear foot	625	600	375,000
Ramp from Rte. 1A SB to Rte. 145 WB Segment #1	One-lane roadway on embankment	linear foot	625	600	375,000
Ramp from Rte. 1A SB to Rte. 145 WB Segment #2	One-lane roadway at grade	linear foot	300	500	150,000
Ramp from Rte. 1A SB to Rte. 145 EB	Two-lane roadway at grade	linear foot	375	150	56,250
Ramp from Rte. 145 WB to Rte. 1A SB Segment #1	One-lane roadway at grade	linear foot	300	200	60,000
Ramp from Rte. 145 WB to Rte. 1A SB Segment #2	One-lane roadway on embankment	linear foot	625	650	406,250
Ramp from Rte 145 EB to Rte. 1A SB	One-lane roadway at grade	linear foot	100	300	30,000
Subtotal					$3,796,750
Route 16/Route 145 EB					
W. project limit to beginning of upgrade	Three-lane roadway at grade	linear foot	375	300	112,500
Beginning of up-grade to railroad viaduct	Three-lane roadway on embankment	linear foot	750	450	337,500
Viaduct over railroad & bikeway	Three lane viaduct	linear foot	10,000	200	2,000,000
Railroad viaduct to grade	36' roadway on embankment	linear foot	750	800	600,000
Grade to Rte. 1A NB off-ramp	Four-lane roadway at-grade	linear foot	500	850	425,000
Rte. 1A NB off-ramp to Suffolk Downs intersection approach	Three-lane roadway at grade	linear foot	375	1,400	525,000
Suffolk Downs intersection approach through Suffolk Downs intersection	Four-lane roadway at-grade	linear foot	500	400	200,000
Suffolk Downs intersection to Revere Beach Parkway (R.B.P.) intersection approach	Three-lane roadway at grade	linear foot	375	400	150,000
R.B.P. approach through R.B.P. intersection	Four-lane roadway at-grade	linear foot	500	400	200,000
R.B.P. intersection to easterly project limit	Three-lane roadway at grade	linear foot	375	250	93,750
Subtotal					$4,643,750

[1]Does not include costs of bikeway/pedestrianway/linear park facilities.

Table 4-8 (Cont'd)
Construction Cost Estimate for Route 1A/Route 16 Alternative 4[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 145/Route 16 WB					
E. project limit through R.B.P. intersection	Four-lane roadway at grade	linear foot	500	450	225,000
R.B.P. Intersection to Suffolk Downs intersection approach	Three-lane roadway at grade	linear foot	375	200	75,000
Suffolk Downs intersection approach through intersection	Four-lane roadway at grade	linear foot	500	400	200,000
Suffolk Downs intersection to on-ramp from Rte. 1A NB	Three-lane roadway at grade	linear foot	375	1630	611,250
On-ramp from Rte. 1A NB to Rte 1A SB off-ramp	Four-lane roadway at grade	linear foot	500	600	300,000
Rte. 1A SB off-ramp to beginning of grade	Three-lane roadway at grade	linear foot	375	300	112,500
Beginning of grade to viaduct	Three-lane roadway on viaduct	linear foot	750	750	562,500
Viaduct over railroad and bikeway	Three-lane viaduct	linear foot	10,000	200	2,000,000
Railroad/bikeway viaduct to grade	Three-lane roadway on embankment	linear foot	750	500	375,000
Grade to westerly project limit	Four-lane roadway at grade	linear foot	500	300	150,000
Subtotal					$4,611,250
Revere Beach Parkway: Mill Street to Winthrop Avenue					
Segment 1: Mill Street to Vinal Street	22' roadway at-grade	linear foot	300	1,050	315,000
Segment 2: Vinal Street to Winthrop Avenue	44' roadway at-grade	linear foot	400	1,100	440,000
Subtotal					$755,000

[1] Does not include costs of bikeway/pedestrianway/linear park facilities.

Table 4-8 (Cont'd)
Construction Cost Estimate for Route 1A/Route 16 Alternative 4[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Revere Beach Parkway: Winthrop Avenue to Easterly Project Limit					
Winthrop Avenue intersection to railroad viaduct	44' roadway at-grade	linear foot	400	250	100,000
Railroad viaduct	Four lane viaduct	linear foot	11,500	100	1,150,000
Railroad viaduct to N. Shore Road intersection	44' roadway at-grade	linear foot	400	2,300	920,000
Local access roadway	22' roadway at-grade	linear foot	300	900	270,000
N. Shore Rd. intersection to New Rte. 145 intersection	Four lanes at-grade, 78' wide	linear foot	750	800	600,000
New Rte. 145 intersection to easterly project limit	Four lanes at-grade, 78' wide	linear foot	750	250	187,500
Subtotal					$3,227,500
Traffic Signals and Miscellaneous					
Signals at westerly cloverleaf limit	Traffic signals	per intersection	75,000	1	75,000
Signals at new Rte. 145 / Suffolk Downs intersection	Traffic signals	per intersection	75,000	1	75,000
Signals at new Rte. 145 / Revere Beach Parkway intersection	Traffic signals	per intersection	75,000	1	75,000
Signals at Winthrop Ave. / Old Rte. 16 intersection	Traffic signals	per intersection	75,000	1	75,000
Signals at new Revere Beach Parkway / North Shore Road intersection	Traffic signals	per intersection	75,000	1	75,000
Subtotal					$375,000
Combined Total					$28,698,500
		Signage, pavement markings and landscaping (10%)			$2,869,850
		Traffic management (10%)			$2,869,850
				Subtotal	$34,438,200
		Contingencies (15%)			$5,165,730
				Grand Total	$39,603,930

[1] Does not include costs of bikeway/pedestrianway/linear park facilities.

4.3 Route 1, North of Copeland Circle

With the Routes 1/16 and 1A/16 interchanges improved to allow connections between Route 1 and Route 1A, Route 1 north of Copeland Circle requires improvements to the Lynn/Salem Street and Route 99 interchanges. The poor geometry of the Lynn/Salem Street interchange makes it an unsafe location, a fact reflected in the observation that two of the ramps are used by fewer than 10 vehicles each in the peak hour. Three alternatives were developed, ranging from a minimum level of investment to major reconstruction of Route 1.

Alternative 1: Ramp Changes Only, No Bridge Reconstruction

The first alternative can be accomplished fairly quickly, with a minor investment of funds. This interchange concept converts the quasi-cloverleaf interchange that exists today into, effectively, a diamond interchange, while retaining all movements. The number of ramps would be reduced from seven to four. The second, northern off-ramp from Route 1 northbound would be closed, and a left-turn pocket would be added from the first off-ramp to Salem Street. On the southbound Route 1 side, the southernmost on- and off-ramps, both used by minimal numbers of vehicles, would be closed.

The existing northbound Route 1 climbing lane would be restriped and designated a general-travel lane. At the present time, most vehicles entering from the on-ramp wait for an opening in the second travel lane, rather than using this climbing lane, which results in long queues for the on-ramp. Acceleration and deceleration lanes, currently missing on Route 1, are also proposed. Figure 4-10 shows the alternative.

Alternative 2: Ramp Geometry Changes and Railroad Bridge Reconstruction

Under Alternative 2, the three-lane section in the northbound direction would be extended from Copeland Circle to the first off-ramp to Salem Street. This widening would be coupled with the acceleration lane for the Salem Street on-ramp in the southbound direction. The existing Route 1 bridge located between Copeland Circle and the interchange over the railroad right-of-way would be rebuilt in order to allow a third lane for acceleration (southbound) and deceleration (northbound). This reconstructed bridge would no longer need to accommodate railroad vehicles, as the right-of-way is the proposed path for the Bikeway-to-the-Sea. The ramps would be reconfigured on the southbound side, with the north on-ramp closed in favor of a new south on-ramp with better geometrics and an acceleration lane. Figure 4-11 shows the alternative.

Alternative 3: Consistent Six-lane Roadway, Lynn Street Interchange and Railroad Bridge Reconstruction, New Northbound Barrel at Route 99

Alternative 3 reconstructs the Route 1 bridge over Salem Street/Lynn Street as well as the railroad bridge, allowing for three travel lanes in each direction on Route 1 north from Copeland Circle to Route 99 (where it already has three lanes in each direction). This addition of lanes would require shifting the alignment of Route 1 in the vicinity of Rowes Quarry toward the eastern side, where the right-of-way on the western side is restricted by existing developments. The new on/off-ramps would have acceleration/deceleration lanes, better turning radii, and full movements at their intersections with Lynn and Salem streets. The Route 1 southbound/Lynn Street intersection would probably need to be signalized to accommodate the left turn from the off-ramp. An additional proposal included in this alternative is improvement of the connection between Route 1 northbound and Route 99. The new connection would provide a normal right-lane merge from Route 99 to Route 1 northbound. Figure 4-12 shows the alternative.

Cost Estimations

Tables 4-9 to 4-11 summarize the estimated costs of each alternative.

- Alternative 1 Close three existing ramps, redesign the northbound on-ramp, make minor changes on Salem Street, and designate the existing climbing lane as a third travel lane. Estimated total cost: $235,000.

- Alternative 2 Add third lane on Route 1 (both direction) between Copeland Circle and Lynn Street, reconstruct railroad bridge, and reconfigure Lynn Street interchange. Estimated total cost: $3.9 million.

- Alternative 3 Reconstruct Route 1 as a six-lane highway between Copeland Circle and Route 99. Within this section of roadway, reconstruct the railroad bridge and the Lynn Street interchange, and the Route 1/Route 99 interchange. Estimated total cost: $33.6 million.

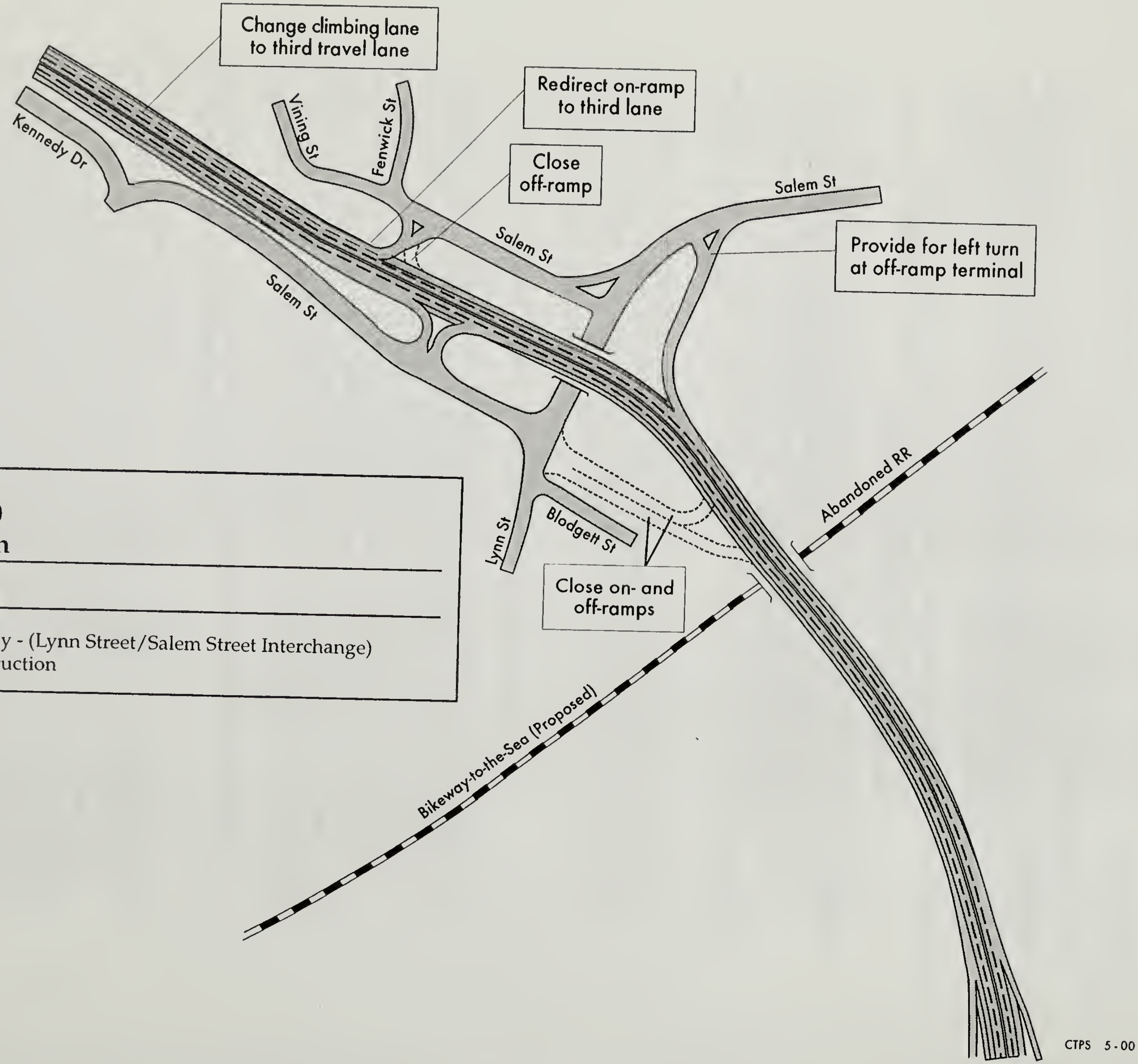


FIGURE 4–10
Route 1 North

Alternative 1

Ramp Changes Only - (Lynn Street/Salem Street Interchange)
No Bridge Reconstruction

Scale: 1" = 350'

FIGURE 4-11
Route 1 North
Alternative 2

Lynn Street Interchange Reconstruction:
Ramps reduced from seven to four
Geometry changes for improved safety
Railroad bridge reconstruction

FIGURE 4-12
Route 1 North
Alternative 3

Route 1 Reconstruction:
Six–lane Route 1 roadway between Copeland Circle and Route 99
New Lynn Street/Salem Street interchange
New northbound barrel at Route 99

Table 4-9
Construction Cost Estimate for
Route 1 North Alternative 1

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1 Northbound					
Build left-turn at first off-ramp terminal	22' roadway at-grade	linear foot	300	200	60,000
Redirect right-turn at on-ramp	22' roadway at-grade	linear foot	300	200	60,000
Close second off-ramp	-	nominal	-	-	10,000
Subtotal					$130,000
Route 1 Southbound					
Close second off-ramp	-	nominal	-	-	20,000
Close second on-ramp	-	nominal	-	-	20,000
Subtotal					$40,000
Combined Total					$170,000
	Signage, pavement markings and landscaping (10%)				$17,000
	Traffic management (10%)				$17,000
				Subtotal	$204,000
	Contingencies (15%)				$30,600
				Grand Total	$234,600

Table 4-10
Construction Cost Estimate for
Route 1 North Alternative 2

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1 Mainline					
NB added lane, Copeland Circle on-ramp to RR viaduct	22' roadway on embankment	linear foot	625	1,000	625,000
SB added lane, RR viaduct to Copeland Circle off-ramp	22' roadway on embankment	linear foot	625	1,000	625,000
Viaduct over abandoned RR/Bikeway-to-the-Sea	Six-lane viaduct	linear foot	15,000	50	750,000
NB added lane, RR viaduct to Lynn St. off-ramp diverge	22' roadway on embankment	linear foot	625	350	218,750
Subtotal					$2,218,750
Route 1 Northbound Off-Ramp					
Route 1 diverge to grade	22' roadway on embankment	linear foot	625	300	187,500
Grade to Salem Street	22' roadway at-grade	linear foot	300	300	90,000
Subtotal					$277,500
Northerly Lynn St./Salem St. Intersection					
Rebuild intersection	Roadway at-grade	nominal	-	-	40,000
Subtotal					$40,000
Route 1 Northbound On-Ramp					
Redirect right-turn at on-ramp	22' roadway at-grade	linear foot	300	200	60,000
Close related off-ramp	-	nominal	-	-	10,000
Route 1 Southbound First On-Ramp					$70,000
Close ramp	-	nominal	-	-	10,000
Subtotal					$10,000
Route 1 Southbound Second On-Ramp					
Lynn Street to embankment start	22' roadway at-grade	linear foot	300	200	60,000
Embankment Start to Route 1 merge	22' roadway on embankment	linear foot	300	300	90,000
Close related off-ramp and old on-ramp	-	nominal	-	-	40,000
Subtotal					$190,000
Combined Total					$2,806,250

Table 4-10 (Cont'd)
Construction Cost Estimate for
Route 1/Lynn Street/Salem Street Interchange Alternative 2

Signage, pavement markings and landscaping (10%)		$280,625
Traffic management (10%)		$280,625
	Subtotal	$3,367,500
Contingencies (15%)		$505,125
	Grand Total	$3,872,625

Table 4-11
Construction Cost Estimate for Route 1 North Alternative 3[1]

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1 Mainline					
New eight-lane Route 1, Copeland Circle ramps to RR overpass	130' roadway on embankment	Linear foot	2,000	1,000	2,000,000
Retaining wall on eastside of Route 1, Copeland Circle ramps to RR overpass	Average 15' high	Linear foot	600	1,000	600,000
New Route 1 Viaduct over abandoned RR/Bikeway-to-the-Sea	Eight-lane viaduct	Linear foot	18,500	50	925,000
New six-lane Route 1, RR overpass to Lynn Street overpass	110' roadway on embankment	Linear foot	1,900	600	1,140,000
New Route 1 Viaduct over Lynn Street	Eight-lane viaduct (staged)	Linear foot	25,000	80	2,000,000
New six-lane Route 1, Lynn Street overpass to embankment end	110' roadway on embankment	Linear foot	1,900	300	570,000
New six-lane Route 1, embankment end to north of Rowes Quarry	110' roadway at-grade	Linear foot	825	2800	2,310,000
Ledge cut work on the eastern side of Route 1 near Rowes Quarry	Approximately 40' wide, 2,330' long, average 15' high, with an expansion factor of 1.375	Cubic yard	40	71,200	2,848,,000
Add-a-lane Route 1 NB and SB, north of Rowes Quarry to Route 99 on/off ramps	Add-a-lane roadway reconstruction	Linear foot	250	4,600	1,150,000
New three-lane Route 1 NB, Route 99 off-ramp diverge to embankment start	Three-lane one-direction roadway at-grade	Linear foot	500	450	225,000
New six-lane Route 1, embankment start to Route 99 overpass	110' roadway on embankment	Linear foot	1,900	400	760,000
New Route 1 Viaduct over Route 99	Six-lane viaduct (staged)	Linear foot	20,000	120	2,400,000
New six-lane Route 1, Route 99 overpass to embankment end	110' roadway on embankment	Linear foot	1,900	400	760,000
New three-lane Route 1 NB, embankment start to northern project limit	Three-lane one-direction roadway at-grade	Linear foot	500	500	250,000
Add-a-lane Route 1 SB, northern project limit to embankment start	Add-a-lane roadway reconstruction	Linear foot	250	500	125,000
Add-a-lane Route 1 SB, embankment end to Route 99 on-ramp merge	Add-a-lane roadway reconstruction	Linear foot	250	450	112,500
Subtotal					$18,175,500

[1] Assumes southern project limit at north Copeland Circle ramps merge/diverge and northern project limit at Collins Avenue in Saugus.

Table 4-11 (Cont'd)
Construction Cost Estimate for
Route 1/Lynn Street/Salem Street Interchange Alternative 3

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1/Lynn St./Salem St. Interchange					
Rt. 1 NB off-ramp, diverge to grade	22' roadway on embankment	Linear foot	625	400	250,000
Rt. 1 NB off-ramp, grade to Salem Street	36' roadway at-grade	Linear foot	375	250	93,750
Rt. 1 NB on-ramp, Salem St. to embank. start	36' roadway at-grade	Linear foot	375	100	37,500
Rt. 1 NB on-ramp, embank. start to Rt. 1 merge	22' roadway on embankment	Linear foot	625	300	187,500
Rt. 1 SB off-ramp, diverge to grade	22' roadway at-grade	Linear foot	625	300	187,500
Rt. 1 SB off-ramp, grade to Lynn Street	36' roadway at-grade	Linear foot	375	150	56,250
Rt. 1 SB on-ramp, Lynn Street to embank. start	36' roadway at-grade	Linear foot	375	200	75,000
Rt. 1 SB on-ramp, embank. start to Rt. 1 merge	22' roadway on embankment	Linear foot	625	300	187,500
Subtotal					$1,075,000
Route 1/Route 99 Interchange					
Rt. 1 NB off-ramp, diverge to Rt. 99	22' roadway at-grade	Linear foot	300	1,350	405,000
Rt. 1 NB on-ramp, Rt. 99 to Rt. 1 merge	22' roadway at-grade	Linear foot	300	1,350	405,000
New two-lane local access road	36' roadway at-grade	Linear foot	375	1,500	562,500
Two-lane Rt. 99, access road to Rt. 1 NB ramps	36' roadway at-grade	Linear foot	375	200	75,000
Rt. 99 underpass Rt. 1	78' roadway cut	Linear foot	1,200	250	300,000
Retaining walls on Rt. 99 cut section	25' high	Linear foot	1,200	500	600,000
Slip ramp from Rt. 99 WB to Rt. 1 SB	22' roadway at-grade	Linear foot	300	150	45,000
Subtotal					$2,392,500
Traffic Signals and Other					
Traffic Signals at Lynn/Salem St. interchange	Traffic signals	per intersection	75,000	2	150,000
Traffic Signals at Rt. 99and Rt. 1 NB ramps	Traffic signals	per intersection	75,000	1	75,000
General demolition of old Rt. 1/Rt. 1 viaducts	-	total estimate	-	-	2,500,000
Subtotal					$2,725,000
Combined Total					$24,368,000
	Signage, pavement markings and landscaping (10%)				$2,436,800
	Traffic management (10%)				$2,436,800
				Subtotal	$29,241,600
	Contingencies (15%)				$4,386,200
				Grand Total	$33,627,800

4.4 New Route 1A/Chelsea Street Bridge Connection

Lack of good access to Chelsea from Route 1A and Logan Airport, and the presence of regional trucks on local Chelsea streets, were two of the biggest concerns expressed by Chelsea in this study. The Chelsea Street Bridge Connector, which provides direct access to the new Chelsea Bridge, is designed to improve these problems.

The new connection would not only improve access to Chelsea and provide a direct path for trucks, but it would draw traffic away from Day Square in East Boston, which all Chelsea-bound traffic currently uses. In addition, it could move air freight traffic between Logan Airport and Chelsea. Figure 4-13 shows the proposed connection.

The estimated cost for a direct connection between Route 1A and the Chelsea Street Bridge is $34.8 million. Table 4-12 shows the breakdown of these costs.

4.5 Brown Circle

Brown Circle is located at the junction of Route 60 and Route 107 in Revere. The rotary has four legs, each with two lanes entering and two exiting except the southern leg, which only has one approaching and one departure lane. The rotary carries heavy volumes during the peak commute hours in all directions, resulting in a poor level of service (LOS) and a high accident rate. The community is concerned about how the rotary will operate once the Mahoney Circle project is completed.

Route 60 is a four-lane east-west major arterial that is currently the primary connector between Route 1 and Route 1A and Logan Airport. It also connects the lower North Shore communities to interior communities and highways north of Boston, such as Malden, Medford, and Interstate 93. Route 107 is a four-lane major arterial on the north side of Brown Circle that connects Revere to Lynn and other communities to the north. South of Brown Circle, Route 107 is a two-lane street that travels through Revere's central business district and is commonly referred to as Broadway.

During both the AM and PM peak hours, the rotary currently operates at LOS E, which is defined as being at capacity. During the AM peak hour, the heaviest volumes entering the rotary are from Route 107 southbound and Route 60 eastbound. The heaviest departure volume is to Route 60 eastbound. The high number of left-turning vehicles from Route 107 southbound interferes with the Route 60 eastbound approach. The combination of left-turning traffic from Route 107 southbound and through and left-turning traffic from Route 60 eastbound within the rotary makes it extremely difficult for Broadway traffic to find sufficient gaps to enter as well. Although Route 60 westbound has a high number of vehicles entering the rotary, it operates at LOS B since most vehicles circulating within the rotary depart for Route 60 eastbound.

During the PM peak hour, most of the traffic entering the rotary originates from Route 60 westbound and exits to Route 107 northbound and Route 60 westbound. This creates long queues on Route 60 westbound as traffic waits for a gap against the still busy circulating traffic within the rotary. This queue, however, usually dissipates from time to time due to the upstream signal at Revere Street. The traffic approaching from Broadway also experience long waits entering the rotary due to the single-lane approach and the heavy Route 60 eastbound volume.

With the high number of vehicles using this rotary, it is common for motorists to force their way into the rotary, cutting off the circulating traffic, which leads to a high accident rate. The Mahoney Circle Grade Separation Study showed that 117 accidents occurred at Brown Circle in 1993, only 14 fewer than the number that occurred at Mahoney Circle (the second-highest accident location in Massachusetts between 1990 and 1993) the same year. The majority of the

FIGURE 4-13
Route 1A/Chelsea Street Bridge

Proposed Impovements

Table 4-12
Construction Cost Estimate for Route 1A/Chelsea Street Bridge Connection

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Route 1A Mainline Northbound					
Bennington Street to Saratoga Street	Three lane viaduct	linear foot	10,000	750	7,500,000
Saratoga Street to new overpass	Three lane embankment	linear foot	1,000	450	450,000
New overpass to Addison Street	44' roadway at-grade	linear foot	400	1,300	520,000
Subtotal					$8,470,000
Route 1A Mainline Southbound					
Addison Street to new overpass	44' roadway at-grade	linear foot	400	1,150	460,000
New overpass to on-ramp merge	Three lane embankment	linear foot	1,000	250	250,000
Ramp merge to Saratoga Street	Four lane embankment	linear foot	1,200	500	600,000
Saratoga Street to Bennington Street	Three lane viaduct	linear foot	10,000	500	5,000,000
Subtotal					$6,310,000
Connector between Route 1A NB & Chelsea Street Bridge					
Bennington Street to new overpass	One lane viaduct	linear foot	4,500	800	3,600,000
New bridge over Rte. 1A NB & SB	One lane viaduct	linear foot	4,500	400	1,800,000
New bridge to Chelsea Street Bridge approach	44' roadway at-grade	linear foot	400	400	160,000
Subtotal					$5,560,000
Connector between Chelsea Street Bridge & Route 1A SB					
Chelsea St. Bridge approach to overpass embankment	44' roadway at-grade	linear foot	400	300	120,000
Embankment to overpass	One lane embankment	linear foot	625	200	125,000
New bridge to Route 1A SB	One land viaduct	linear foot	4,500	350	1,575,000
Subtotal					$1,820,000
Ramp from East Boston Local to Chelsea Street Bridge					
Saratoga Street to beginning of grade	22' roadway at-grade	linear foot	300	350	105,000
Beginning of grade to overpass	One lane embankment	linear foot	625	400	250,000
New bridge over Route 1A NB & SB	One lane viaduct	linear foot	4,500	350	1,575,000
Subtotal					$1,930,000

Table 4-12 (Cont'd)
Construction Cost Estimate for Route 1A/Chelsea Street Bridge Connection

Construction Element/Subelement	Type of Construction	Unit Cost Measure	Unit Cost	Number of Units	Total Cost
Ramp from Chelsea Street Bridge to East Boston Local					
Connector roadway to grade	One lane embankment	linear foot	625	400	250,000
Roadway to Saratoga Street	22' roadway at-grade	linear foot	300	950	285,000
Subtotal					$535,000
Ramp from East Boston Local to Rte. 1A NB					
Chaucer Street to Rte. 1A merge	22' roadway at-grade	linear foot	300	500	150,000
Subtotal					$150,000
Ramp from Rte. 1A SB to East Boston Local					
Rte. 1A diverge to connector ramp merge	22' roadway at-grade	linear foot	300	1,500	450,000
Subtotal					$450,000
Combined Total					$22,225,000
	Signage, pavement markings and landscaping (10%)				$2,522,500
	Traffic management (10%)				$2,522,500
				Subtotal	$30,270,500
	Contingencies (15%)				$4,540,575
				Grand Total	$34,810,575

accidents at Brown Circle were merge and sideswipe (64%), followed by rear-end accidents (21%). Two alternatives were developed to improve the poor LOS and the high accident rate at Brown Circle.

Alternative 1: Signalization of Brown Circle

The first alternative considered was to convert the rotary into a standard four-legged, signalized intersection. The intersection would be channelized so as to adequately handle and store the turning vehicles, while remaining as much as possible inside the existing right-of-way. The land currently occupied by the rotary and the wide medians on most approaches allow for the necessary long storage lanes for left-turning traffic. Most of the approaches would require two left-turn lanes to store the vehicles and put as many turning vehicles through as possible without negatively affecting other movements during exclusive phases. The southbound Route 107 approach and the westbound Route 60 approach would also require exclusive right-turn lanes to handle those heavy volumes. Figure 4-14 shows the proposed design and the proposed phasing and timing plan based on the existing volumes.

Analysis of the proposed phasing and timing plan indicates that this signal would operate at an overall LOS D and C during the AM and PM peak hours, respectively, with no approach experiencing a LOS lower than D. The AM peak would have a lower LOS due to the high number of left turns from Route 107 southbound to Route 60 eastbound. Installation of a traffic signal at Brown Circle should also reduce accidents at this location, especially the merge-related types of accidents, such as sidewipes.

Alternative 2: Grade Separation of Route 60 Through Traffic from Rotary

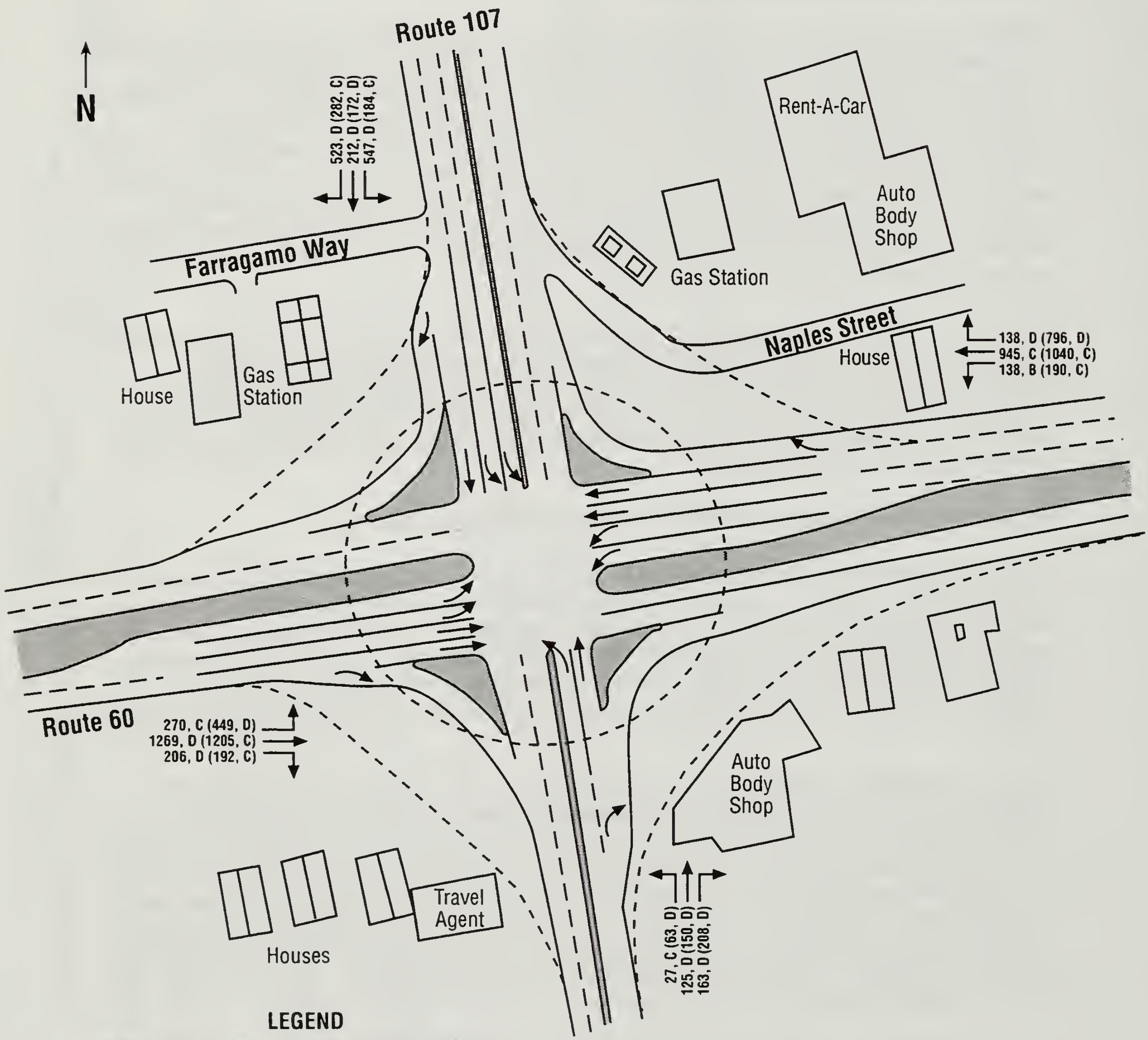
Removing a portion of the existing volumes from the rotary would improve traffic flow and reduce accidents. Route 60 has the most through traffic, and removing these vehicles from the rotary would make the most sense. This could be accomplished by constructing an overpass or underpass separating Route 60 from Brown Circle, and building on- and off-ramps to connect Route 60 main lines to the rotary. The ramps would continue to allow all turning movements within Brown Circle. The Route 107 approaches would be unaffected. Figure 4-15 shows the alternative.

Using the same SIDRA[1] (Signalized and unsignalized Intersection Design and Research Aid) analysis used to model the existing rotary conditions, the through movements entering Brown Circle on Route 60 were removed and the intersection was reanalyzed. The results show that the LOS in the AM peak hour for the rotary would be LOS A. Due to the heavy vehicular movement from Route 60 westbound to Route 107 northbound during the PM peak hour, the off-ramp from Route 60 westbound to the rotary would need to be two lanes. According to the SIDRA analysis, a single off-ramp at this location would operate at LOS F, but a two-lane off-ramp entering the rotary would be LOS C and result in an overall LOS B for the entire rotary. All other on- and off-ramps to and from Route 60 could remain one lane.

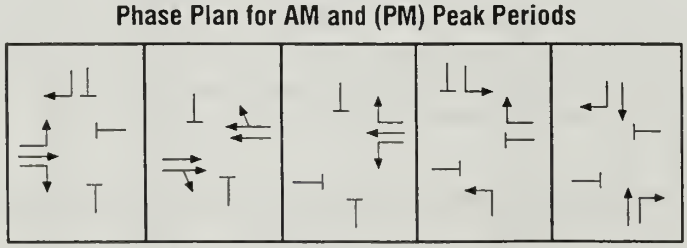
Grade separation of Brown Circle would bring about a greater improvement in the operations at the rotary than would signalization, but it would also be a more expensive solution and might require some additional right-of-way. However, this option would help turn Route 60 into a free-flow highway to be used as the primary connector to Route 1A and Logan Airport for North Shore communities. This study's recommendation that Route 16 be made the primary connector and that through-town traffic be diverted away from Route 60 makes this option a less attractive alternative than it would be outside the context of that recommendation.

[1] SIDRA5, Rahmi Akcelik and Mark Besley, ARRB Transport Research Ltd., January 1998.

Figure 4-14
Existing Traffic Volumes and Estimated Levels of Service
Brown Circle Signalization

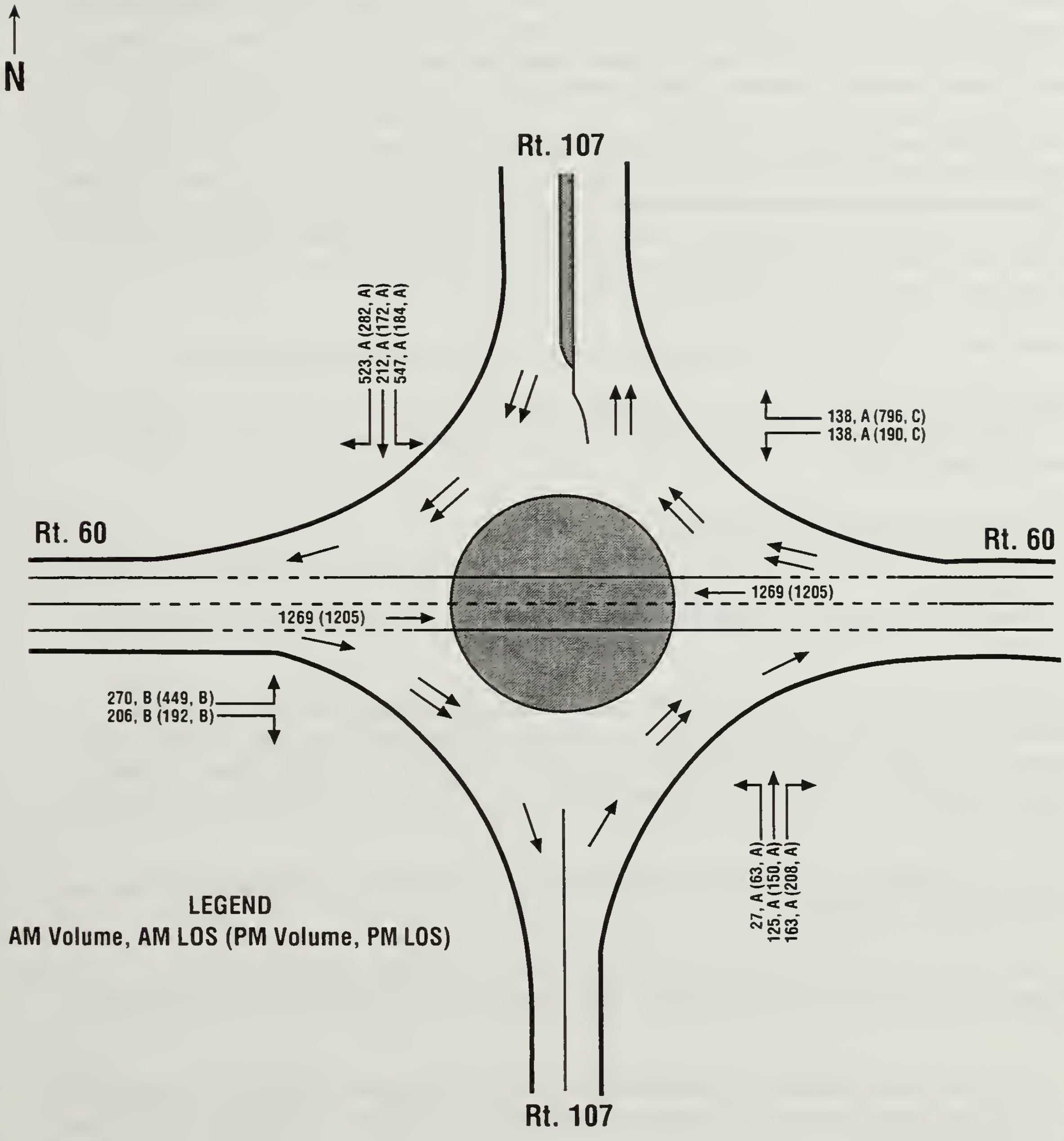


Phase Plan for AM and (PM) Peak Periods



SECONDS					
Green:	16.0 (12.0)	18.0 (20.0)	5.0 (5.0)	13.0 (13.0)	11.0 (13.0)
Yellow + all red:	5.0 (5.0)	5.0 (5.0)	5.0 (5.0)	5.0 (5.0)	4.0 (5.0)

Figure 4-15
Existing Traffic Volumes and Estimated Levels of Service
Brown Circle Grade Separation



4.6 Route 60 Corridor between Brown Circle and Copeland Circle

CTPS also investigated improvements to Route 60 between Brown and Copeland circles. The CTPS travel time studies indicate congestion and delay at the Brown Circle rotary. Delay and congestion on Route 60 WB during the PM peak between Brown Circle and Copeland Circle (Route 1) far outweighs the Brown Circle approaches. This is primarily due to the two traffic signals in the vicinity of the Northgate Shopping Center at Sigourney Street and Charger Street. The signals allow left turns from Route 60 to the Northgate Shopping Center and vice versa, and queues develop at the two intersections due to the high volume of left turns. In the PM peak hour, queues on Route 60 westbound can extend from Charger Street into Brown Circle.

Two improvement alternatives were proposed: (1) signal progression all the way from Revere Street to the Northgate Mall (including new signals at Brown Circle), and (2) removal of signals and the prohibition of left turns between Brown and Copeland circles. In the second alternative, left turns would be accomplished via U-turns at Brown Circle or Copeland Circle and a new entrance to the Northgate Shopping Center might be feasible using existing unfinished ramps out of Copeland Circle or a newly improved Ward Street behind the mall.

Alternative 1: Coordinate Traffic Signals between Revere Street and Copeland Circle

This alternative could accompany the signalization of Brown Circle described above (Alternative 1), or could accompany a do-nothing alternative at Brown Circle. The main points of this alternative are that it:

- Allows all existing turns to still occur
- Reduces travel time and delays currently encountered between Brown Circle and Copeland Circle
- Is not able to completely eliminate congestion at the intersection of Route 60 and Revere Street

The existing wide median on Route 60 allows for additional through or left turn lanes to be added if necessary. Current volumes do not warrant additional expansion, and the alternatives proposed for the Route 1/Route16 and Route 1A/Route 16 connections in this study should, if implemented, reduce future traffic volumes on Route 60. However, future expansion remains an option if needed.

Alternative 2: Eliminate Two Traffic Signals, Relocate Access to Northgate Shopping Center, and Close the Route 60 Median

This alternative is proposed as an accompaniment to the Brown Circle grade separation alternative (Alternative 2) described above. The main components of the present alternative are that it:

- Eliminates traffic signals at Northgate Shopping Center (Sigourney Street) and Charger Street
- Prohibits all median crossings and closes the median on Route 60 between Brown Circle and Copeland Circle
- Allows right turns from Route 60 WB to the shopping center and vice versa
- Uses Brown Circle as a U-turn point for Route 60 EB traffic and local traffic south of Route 60 wishing to access Northgate Shopping Center and Route 60 WB
- Uses Copeland Circle as a U-turn point for Route 60 WB traffic and local traffic north of Route 60 wishing to access the area south of Route 60 and Route 60 EB

- Provides free-flow traffic conditions between Brown Circle and Copeland Circle, and a much-improved travel time

This alternative in combination with the Brown Circle grade separation alternative would provide free-flow traffic conditions all along Route 60. The only remaining traffic signal on Route 60 between Mahoney Circle and Brown Circle would exist at Revere Street, where a grade separation option could also be considered.

An additional element of this alternative includes relocating the main entrance to the shopping center off of Copeland Circle. In the northeast quadrant of Copeland Circle, between the west approach of Route 60 and the north approach of Route 1, there are uncompleted ramps that were once planned for the I-95 north project that was halted in the 1970s. The ramps could be used to tie into the rear of Northgate Shopping Center's parking lot and serve as its primary entrance and exit. If this were implemented, the impact on business at the shopping center due to the closure of the Route 60 median would be reduced.

5 TRAVEL DEMAND FORECASTS

In order to ascertain the extent of future travel demand and whether the demand can be accommodated by the proposed long-range alternatives, CTPS developed a set of future-year (2020) travel demand forecasting models. Based on the future traffic volumes predicted by the models, CTPS estimated the effects of the alternatives on travel patterns in the study area and on the levels of service of new signalized intersections. The method used to examine these effects involved combining the alternatives into "packages." This chapter, after describing how the travel demand forecasting models were developed and defining the packages of alternatives, summarizes the travel patterns and intersection levels of service predicted under the various packages.

5.1 Development of Travel Demand Forecasting Models

The modeling area is somewhat larger than the study area. In addition to the five study-area communities (Chelsea, East Boston, Everett, Malden, and Revere), it includes Winthrop, Charlestown, and a portion of the I-93 corridor in Somerville. CTPS modeled two time periods: the AM peak hour and the PM peak hour. The base year under study is 1996 and the future year is 2020.

The base-year network was windowed from the CTPS regional network (covering 164 communities in eastern Massachusetts). It was then exported to TRIPS,[1] and more links and traffic zones were added for analysis purposes. These network modifications included detailed coding of Mahoney Circle, Sweetzer Circle, Santilli Circle, and the Wellington MBTA station area, and additional traffic zones for the Suffolk Downs area, the Wonderland area, Northgate Shopping Center, the future Gateway Shopping Center, Wellington Station, and the future Telecom City development. The resulting traffic zone system consists of 92 internal traffic zones and 24 external stations (Figure 5-1).

The base-year trip table was extracted from the regional peak-period highway vehicular trip table. It was expanded in accordance with the addition of traffic zones, and then factored from peak period (6:00–9:00 AM, 3:00–6:00 PM) to peak hour using factors (0.42 for AM, 0.40 for PM) derived from study area trip information from the 1991 Household Home Interview Survey. The extracted trip table was used as a seed table and was reestimated (calibrated) based on available recent traffic counts. The calibration was conducted using the trip table estimator of TRIPS.

The future-year model was developed based on forecasts of employment and population. These were mostly Urban Ring Project forecasts, which were primarily assembled by the Metropolitan Area Planning Council in consultation with city and town planners in 1996 and 1997. Some employment projections in the study area were adjusted based on information provided by TAC members.

Table 5-1 shows the base-year (1996) and future-year (2020) population, household, and employment figures that were used in this study, listed by city/town and traffic zone. Population is expected to stay almost the same, but households are expected to increase by 7%, as average household size is predicted to decrease somewhat. However, employment is expected to increase by 25.5%, as the study area's commercial attractiveness is expected to grow when the

[1] TRIPS, Version 7.1, MVA Systematica, March 1997.

Table 5-1
Lower North Shore Area Population, Household, and Employment Forecasts

City/Town/ Neighborhood	Traffic Zone	Population			Household			Employment		
		1996	2020	Change	1996	2020	Change	1996	2020	Change
East Boston	1	1,527	1,540	13	588	625	37	31	31	0
East Boston	2	2,583	2,612	29	1,005	1,071	66	387	387	0
East Boston	3	0	0	0	0	0	0	450	686	236
East Boston	4	2,103	2,132	29	978	1,045	67	241	391	151
East Boston	5	1,692	1,721	29	662	710	48	1,030	1,051	21
East Boston	6	1,570	1,599	29	662	711	49	898	971	72
East Boston	7	1,211	1,240	29	493	532	39	92	92	0
East Boston	8	1,927	1,942	15	816	867	51	327	327	0
East Boston	9	2,799	2,828	29	1,052	1,120	68	181	181	0
East Boston	12	2,159	2,188	29	946	1,011	65	406	406	0
East Boston	57	1,328	1,340	12	485	516	31	244	244	0
East Boston	58	1,214	1,220	6	575	609	34	189	189	0
East Boston	59	1,451	1,463	12	544	578	34	59	59	0
East Boston	60	1,756	1,948	192	740	867	127	545	545	0
East Boston	61	51	51	0	27	28	1	399	399	0
East Boston	62	302	302	0	125	132	7	816	816	0
East Boston	64	65	65	0	30	32	2	104	104	0
Logan Airport	21	0	0	0	0	0	0	13,225	14,223	998
Logan Airport	76	0	0	0	0	0	0	780	803	23
Logan Airport	77	0	0	0	0	0	0	465	1,115	650
Logan Airport	78	48	48	0	23	24	1	820	820	0
Orient Heights	10	1,961	1,990	29	810	866	56	100	100	0
Orient Heights	11	5,145	5,603	458	2,036	2,348	312	1,172	1,172	0
Orient Heights	80	70	76	6	23	27	4	160	160	0
Orient Heights	63	1,979	2,132	153	797	909	112	1,211	1,211	0
Chelsea	22	3,823	3,926	103	1,308	1,480	172	952	1,055	103
Chelsea	23	1,114	1,449	335	692	991	299	359	359	0
Chelsea	24	2,781	3,015	234	946	1,131	185	5,392	6,098	705
Chelsea	25	7,771	7,615	-156	3,053	3,294	241	2,085	3,935	1,850
Chelsea	26	7,010	6,840	-170	2,648	2,839	191	950	1,048	98
Chelsea	92	145	132	-13	60	60	0	400	700	300
Chelsea	27	6,036	6,086	50	1,837	2,040	203	921	1,126	205
Revere	33	6,165	6,222	57	2,384	2,546	162	1,039	987	-52
Revere	34	4,262	4,295	33	1,623	1,730	107	436	523	87
Revere	35	5,131	4,944	-187	1,862	1,896	34	779	765	-14
Revere	82	311	300	-11	169	172	3	560	692	132
Revere	83	933	899	-34	298	304	6	211	340	129
Revere	36	4,580	4,443	-137	1,995	2,047	52	1,155	1,479	324
Revere	37	3,599	3,654	55	1,610	1,778	168	435	412	-23
Revere	81	1,644	1,644	0	820	820	0	928	1,697	769
Revere	38	4,484	4,353	-131	1,822	1,871	49	1,146	1,200	54
Revere	39	7,418	7,130	-288	3,050	3,101	51	1,448	1,717	269
Revere	40	4,259	4,140	-119	1,805	1,856	51	163	163	0
Everett	50	7,760	7,571	-189	3,114	3,208	94	1,651	1,652	0
Everett	51	7,709	7,523	-186	3,152	3,249	97	571	591	20
Everett	52	5,746	5,686	-60	2,318	2,423	105	634	695	61
Everett	53	4,196	4,378	182	1,700	1,877	177	2,251	1,429	-822

(cont.)

Table 5-1, cont.
Lower North Shore Area Population, Household, and Employment Forecasts

City/Town/ Neighborhood	Traffic Zone	Population			Household			Employment		
		1996	2020	Change	1996	2020	Change	1996	2020	Change
Everett	90	0	0	0	0	0	0	0	4,521	4,521
Everett	54	5,702	5,645	-57	2,386	2,495	109	1,757	1,756	-2
Everett	55	3,491	3,575	84	1,470	1,590	120	340	361	21
Everett	56	1,097	1,027	-70	388	384	-4	4,906	5,160	254
Everett	84	0	0	0	0	0	0	0	1,150	1,150
Malden	41	8,269	7,974	-295	3,443	3,499	56	2,274	2,330	56
Malden	42	6,330	6,124	-206	2,557	2,609	52	1,478	1,482	4
Malden	43	3,657	3,571	-86	1,894	1,950	56	1,410	1,411	1
Malden	87	476	626	150	241	319	78	6,741	8,570	1,829
Malden	44	5,785	5,601	-184	2,249	2,295	46	384	355	-29
Malden	91	0	86	86	0	37	37	1,065	1,678	613
Malden	45	4,349	4,232	-117	1,560	1,601	41	989	1,093	103
Malden	88	3,023	2,968	-55	1,198	1,240	42	198	241	43
Malden	46	3,173	3,141	-33	1,301	1,358	57	602	561	-41
Malden	47	5,440	5,272	-168	2,126	2,173	47	314	283	-31
Malden	48	6,504	6,287	-217	2,561	2,611	50	2,798	2,883	86
Malden	49	7,211	8,368	1,157	2,925	3,590	665	1,223	3,088	1,865
Medford	85	32	383	351	16	192	176	287	2,026	1,739
Medford	86	3,179	3,179	0	1,346	1,458	112	1,297	3,184	1,887
Medford	89	4,342	4,594	251	1,875	2,196	321	3,775	3,956	180
Total		**201,878**	**202,934**	**1,056**	**81,219**	**86,939**	**5,720**	**80,638**	**101,236**	**20,598**
Total % Growth				**0.52%**			**7.04%**			**25.54%**

completion of the Central Artery and other transportation projects increases its accessibility, especially to nearby Boston. Among the employment increases, those associated with the Mellon Bank, Telecom City, Gateway Shopping Center, and Mystic Center projects are expected to have the most substantial impact on the area. Other major developments include expansions of Mystic Plaza and Parkway Center, some manufacturing and warehouse expansions in Chelsea, and three new hotels in Revere.

The socioeconomic forecasts were input to the 2020 CTPS regional model, and a preliminary future-year network and a seed future-year trip table[2] for this study were then extracted from the regional model. The preliminary future-year network was updated by adding the new links and new traffic zones in the study area. It was further updated based on the assumption that the following projects will be completed by 2020:

- Central Artery/Tunnel
- Grade separation at Mahoney Circle – Alternative 1 in the feasibility study[3]
- Grade separation at Boardman Street
- Three lanes on Route 1A from Boardman Street to Mahoney Circle
- MBTA Urban Ring Project
- MBTA Blue Line extension to Beverly
- Improvements to Sweetzer Circle from Gateway Shopping Center project

[2] This seed trip table would be further adjusted.
[3] *Mahoney Circle Grade Separation Feasibility Study, Final Report*, Vollmer Associates with Sam Park Associates, prepared for MassHighway, June 1997.

- Better connection between Commercial Street and Corporation Way
- Access from Route 16 westbound to Parkway Center Redevelopment in Chelsea

This future-year base network was used as a future "no-build" scenario. The various future-year long-range alternatives were then built upon this base.

The future-year trip table was obtained by applying a set of calibration factors to the seed trip table. The calibration factors were derived by comparing the base-year calibrated trip table to the base-year seed trip table (difference of cell value to cell value). After application of the factors, the trip table was checked for reasonableness of cell values, especially for the major external stations and the internal traffic zones with major trip generators, and necessary adjustments were made based on base-year count extrapolation and employment classification analysis.

5.2 Alternative Packages for Analysis

For analysis purposes, long-range improvement alternatives were bundled into packages representing combinations of alternatives that might be recommended. Forecasts of future traffic volumes were developed for each package.

A fundamental problem identified in the study area is the poor connections between Route 1 north (serving North Shore communities) and Route 1A south (including access to the tunnels and the airport). The long-range alternatives, except those for Route 1 north of Copeland Circle and the Route 1A/Chelsea Street Bridge connection, were aimed in large part at addressing this problem. Basically, an improved connection between Route 1 and Route 1A can be accomplished via either Route 60 or Route 16. The packages of alternatives may be grouped according to which of the two competing ideas they employ. Table 5-2 summarizes the combinations of alternatives at the various locations for each package.

Table 5-2
Alternative Packages for Analysis

Long-Range Alternative	Alternative Packages										
	1	2	3	4	5	6	7	8A	8B	8C	9
Route 1/16 Interchange Alternative 1			X		X						
Route 1/16 Interchange Alternative 2						X					
Route 1/16 Interchange Alternative 2 Revised											X
Route 1/16 Interchange Alternative 3							X				
Route 1/16 Interchange Alternative 4				X				X	X	X	
Route 1A/16 Alternative 1	X	X	X								
Route 1A/16 Alternative 2				X							
Route 1A/16 Alternative 3					X	X	X	X	X	X	
Route 1A/16 Alternative 4											X
Route 1 North of Copeland Cir. Alternative 1											
Route 1 North of Copeland Cir. Alternative 2											
Route 1 North of Copeland Cir. Alternative 3		X	X	X	X	X	X	X	X	X	X
Route 1A/Chelsea Street Bridge Connection			X	X	X	X	X	X	X		X
Brown Circle Signalization				X	X	X	X	X			X
Brown Circle Grade-Separation[1]	X	X	X								

1. Includes removing signals along Route 60 from Mahoney Circle to Copeland Circle.

FIGURE 5 -1

Lower North Shore
Transportation Improvement Study

Traffic Zone System

KEY

TOWN BOUNDARIES

TRAFFIC ZONE BOUNDARIES

Packages 1 to 3 make Route 60 the main link between Route 1 and Route 1A. This is accomplished by grade separating Brown Circle and by removing signals and eliminating left turns along Route 60 between Mahoney Circle and Copeland Circle. Packages 4 to 9 propose to utilize Route 16 as the primary link, with improved connections at Route 1 and Route 1A. Package 9 is the package recommended by this study. It was developed based on analyses of the forecasts for Packages 1 to 8C and discussions with TAC members on the feasibility of each alternative.

5.3 Travel Demand Analyses of Alternative Packages

The model runs performed for the various packages of long-range alternatives indicated that they would have significant impacts on travel patterns in the study area in 2020, especially those packages that utilize Route 16 as the primary link between Routes 1 and 1A and provide improved connections between Routes 1 and 1A. Figure 5-2 to 5-23 contain the peak hour traffic volumes along major roadways and levels of service at three intersections (Routes 1/16, Routes 1A/16, and Brown Circle) that were forecasted to result from the implementation of each of the packages are shown in Figures 5-2 to 5-23 (which follow page 149). The sections below summarize the information for, respectively, Packages 1–3, Packages 4–8c, the three new signalized intersections, and the recommended package, Package 9. The percentage increase and decrease in traffic volumes are given in ranges of values in many cases, because the values vary by package and by time period; for more specific data, consult the figures.

Summary of Traffic Impacts Associated with Improved Connections between Route 1 and Route 1A via an Upgraded Route 60 (Packages 1–3)

The travel demand forecasts for Packages 1 to 3 indicated that the Route 60 improvements (including grade separation of Brown Circle, Revere Street, and Mahoney Circle) ease traffic on Route 16 in the section between Route 1 and Route 107 and the section west of Route 1, but attract additional traffic to Route 60 in the section between Copeland Circle and Brown Circle and the section between Brown Circle and Mahoney Circle. Packages 1 and 2 are focused on upgrades to Route 60. Package 3, however, also includes the improved connection between Route 1 and Route 16 (Alternative 1) and therefore produced a somewhat different result. The predicted impacts of Packages 1 and 2 and those of Package 3 are summarized below.

Difference in traffic volumes in the peak direction, compared to 2020 base case:

- Route 60 between Copeland and Brown circles (Revere)
  - Packages 1 & 2: 40–50% increase
  - Package 3: 15–40% increase
- Route 60 between Brown and Mahoney circles (Revere)
  - Packages 1 & 2: 10–20% increase
  - Package 3: Approx. the same as base case
- Route 16 between Route 1 and Route 107 (Chelsea/Everett)
  - Packages 1 & 2: 10–15% decrease
  - Package 3: 5–35% increase
- Route 16 west of Route 1 (Chelsea/Everett)
  - Packages 1 & 2: 10–15% decrease
  - Package 3: 15–20% decrease

- Route 1A south of Route 16 (Revere/East Boston)
  - Packages 1 & 2: 0–5% increase
  - Package 3: 0–5% increase
- Route 107 near Brown Circle (Revere)
  - Packages 1 & 2: 40–100% increase
  - Package 3: 40–100% increase
- Route 107 near Route 16 (Revere)
  - Packages 1 & 2: 5–15% decrease
  - Package 3: 5–15% decrease

Summary of Traffic Impacts Associated with Improved Connections between Route 1 and Route 1A via Route 16 (Packages 4–8C)

Overall, the travel demand forecasts for Packages 4 to 8C indicated that the improved connections between Route 1 and Route 1A via Route 16 direct traffic around Revere and greatly alleviate traffic congestion on Route 60. Under these packages, a large portion of crosstown traffic between Route 1 north (North Shore area) and Route 1A south (Logan Airport, Boston) would be channeled through Route 1 and Route 16, instead of through Route 60 or Route 107, which could then better serve local traffic. The predicted impacts of Packages 4 to 8C are summarized below[4].

Difference in traffic volumes in the peak direction, compared to 2020 no-build base case:

- Route 60 between Copeland and Brown circles (Revere)
  - Packages 4–8C: 25–40% decrease
- Route 60 between Mahoney and Brown circles (Revere)
  - Packages 4–8C: 20–40% decrease
- Route 16 west of Route 1 (Chelsea/Everett)
  - Packages 4–8C: 15–30% decrease
- Route 16 between Route 1 and Route 107 (Chelsea/Revere)
  - Packages 4–8C: 35–70% increase
- Route 1 between Copeland Circle and Route 16 (Revere/Everett)
  - Packages 4–8C: 10–20% increase
- Route 1A south of Route 16 (Revere/East Boston)
  - Packages 4–8C: 10–15% increase
- Route 1A north of Mahoney Circle (Revere)
  - Packages 4–8C: Approx. the same as base case
- Route 107 near Brown Circle (Revere)
  - Packages 4–8C: Approx. 10% decrease
- Route 107 near Route 16 (Revere)
  - Packages 4–8C: 10–30% increase

---

[4] Package 9 (the recommended package) also improves connections between Routes 1 and 1A via Route 16; its traffic impacts are summarized in the concluding section of this chapter.

- Revere Beach Parkway east of Route 1A (Revere)
  - Package 4: Approx. 5% increase
  - Packages 5–8C: Approx. 80% decrease

Summary of Predicted Level of Service at New Signalized Intersections

The predicted 2020 traffic volumes (turning movements) at all the new signalized intersections in each package were input to the Highway Capacity Software program (HCS, based on 1994 Highway Capacity Manual) for intersection level of service (LOS) analysis. The analyses were done at a planning level to determine if an acceptable LOS (A–D) could be achieved through selection of appropriate signal timing under the proposed configuration for each new signalized intersection in each package. Table 5-3 summarizes the LOS analyses for these intersections and for the intersection of Routes 1A and 145 with upgraded signalization.

Route 1/Route 16

With the new signals at the intersection of Route 16 at Route 1, the analysis showed that a single left-turn lane from the Route 1 southbound off-ramp (Route 1/16 Alternative 1; Figure 4-1) would be inadequate to handle the projected volumes. This is shown in the LOS analysis of predicted PM peak hour traffic conditions under Package 3. However, if two left-turn lanes were provided for the off-ramp (Route 1/16 Alternatives 2, 2 Revised, and 3; Figures 4-2, 4-3, and 4-4), the intersection would operate at LOS C or D on all approaches. This is shown in the LOS analyses of predicted AM and PM peak hour conditions under Packages 5, 6, 7, and 9.

At the new signalized left turn from Route 16 westbound to Route 1 northbound, the low turn volumes generated by Package 3 (improvements focusing on Route 60) would be easily accommodated. However, the higher predicted volumes of Package 6 would force either the through vehicles on Route 16 or the left turns to operate at LOS F. This led to the conclusion that the new signal at this location is not appropriate and that a new ramp option (Route 1/16 Alternatives 2–4) is needed for the Route 16 westbound/Route 1 northbound move under any Route 16–preferred package.

Route 16 Extension at Route 1A

Alternative 3 for the intersection of Route 1A and the new extension of Route 16 includes a diamond interchange with signals on Route 16 separating the left-turn and through moves at both the Route 1A northbound and southbound on- and off-ramps (Figure 4-8). Packages 6 through 8C all include Alternative 3, which extends Route 16 through Suffolk Downs to provide a southern connection to Revere Beach.

The new signal on the Route 1A southbound side of the intersection would operate at LOS D or better for both the AM and PM peak hours in all the packages, although some individual moves, principally left turns, might be LOS E or F in the PM peak hour. However, the other new signal (Route 1A northbound side) would have a large number of left turns to and from Route 1A northbound in the PM peak hour (over 2,000) and would operate at LOS F in the PM peak hour under all packages that include it. The LOS analysis showed that even two left-turn and three through lanes are not sufficient to carry the projected volumes through the signal. Alternative 4 (Figure 4-9), a partial cloverleaf grade separation with the Route 1A southbound side signal being retained, was developed to improve operations and was incorporated in Package 9.

Table 5-3
Predicted Level of Service at New or Upgraded Signalized Intersections

Intersection	Package 1		Package 2		Package 3		Package 4		Package 5		Package 6		Package 7		Package 8A		Package 8B		Package 8C		Package 9	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
New - Route 1 SB at Route 16	NA	NA	NA	NA	**D**	**F**	NA	NA	C	C	C	**D**	**D**	D	NA	NA	NA	NA	NA	NA	C	D
LT from SB off-ramp	NA	NA	NA	NA	D	E	NA	NA	D	D	C	D	C	D	NA	NA	NA	NA	NA	NA	C	C
Route 16 WB	NA	NA	NA	NA	D	C	NA	NA	C	B	D	B	D	B	NA	NA	NA	NA	NA	NA	C	B
Route 16 EB	NA	NA	NA	NA	C	F*	NA	NA	C	C	C	D	C	D	NA	NA	NA	NA	NA	NA	B	D
New - Route 1 NB at Route 16	NA	NA	NA	NA	**B**	**B**	NA	NA	**F**	**F**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LT to NB on-ramp	NA	NA	NA	NA	B	C	NA	NA	F	E	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 16 WB	NA	NA	NA	NA	A	A	NA	NA	A	A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 16 EB	NA	NA	NA	NA	C	B	NA	NA	F*	F*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
New - Route 16 Ext. at Route 1A SB	NA	NA	NA	NA	NA	NA	NA	NA	**C**	**C**	**C**	**C**	C	**C**	**D**	C	**D**	C	C	**D**	C	C
Route 16 EB - Through	NA	NA	NA	NA	NA	NA	NA	NA	D	D	D	D	D	D	D	E	F	D	E	F	D	C
Route 16 EB - RT	NA	NA	NA	NA	NA	NA	NA	NA	B	A	B	A	B	A	B	A	B	A	B	A	NA	NA
Route 16 WB - Through	NA	NA	NA	NA	NA	NA	NA	NA	A	A	A	A	A	A	A	B	A	A	A	A	NA	NA
Route 16 WB - LT	NA	NA	NA	NA	NA	NA	NA	NA	E	D	E	D	D	F	D	E	C	D	C	F	NA	NA
RT from SB off-ramp	NA	NA	NA	NA	NA	NA	NA	NA	D	F	D	D	D	F	D	D	D	D	D	D	NA	NA
LT from SB off-ramp	NA	NA	NA	NA	NA	NA	NA	NA	D	D	D	F	D	D	D	E	F	D	D	F	C	C
New - Route 16 Ext. at Route 1A NB	NA	NA	NA	NA	NA	NA	NA	NA	**D**	**F***	**D**	**F***	**D**	**F***	**D**	**F***	**D**	**F***	**D**	**F***	NA	NA
Route 16 EB - Through	NA	NA	NA	NA	NA	NA	NA	NA	A	B	A	B	A	A	A	A	A	A	A	A	NA	NA
Route 16 EB - LT	NA	NA	NA	NA	NA	NA	NA	NA	F	F*	D	F*	F	F	D	D	D	F*	D	F*	NA	NA
Route 16 WB - Through	NA	NA	NA	NA	NA	NA	NA	NA	D	E	D	E	D	E	D	D	D	E	D	D	NA	NA
Route 16 WB - RT	NA	NA	NA	NA	NA	NA	NA	NA	A	A	A	A	A	A	A	A	A	A	A	A	NA	NA
RT from NB off-ramp	NA	NA	NA	NA	NA	NA	NA	NA	B	B	B	B	B	B	B	B	D	B	B	B	NA	NA
LT from NB off-ramp	NA	NA	NA	NA	NA	NA	NA	NA	D	F*	D	F*	D	F*	D	F*	B	F*	D	F*	NA	NA
New - Brown Circle Signalized	NA	NA	NA	NA	NA	NA	**D**	**D**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	NA	NA	NA	NA	**D**	**D**
Route 60 EB - RT	NA	NA	NA	NA	NA	NA	D	B	C	B	C	B	C	B	D	B	NA	NA	NA	NA	C	C
Route 60 EB - Through	NA	NA	NA	NA	NA	NA	D	B	C	B	C	B	C	B	D	B	NA	NA	NA	NA	D	D
Route 60 EB - LT	NA	NA	NA	NA	NA	NA	C	E	C	D	C	C	C	C	C	E	NA	NA	NA	NA	D	D
Route 60 WB - RT	NA	NA	NA	NA	NA	NA	B	D	B	B	B	B	B	C	B	B	NA	NA	NA	NA	B	E
Route 60 WB - Through	NA	NA	NA	NA	NA	NA	C	E	C	D	C	D	C	C	C	C	NA	NA	NA	NA	C	C
Route 60 WB - LT	NA	NA	NA	NA	NA	NA	C	A	C	A	C	A	C	A	C	A	NA	NA	NA	NA	D	C
Route 107 NB - RT	NA	NA	NA	NA	NA	NA	A	A	A	A	A	A	A	A	A	A	NA	NA	NA	NA	C	E
Route 107 NB - Through	NA	NA	NA	NA	NA	NA	C	D	C	C	C	C	C	C	C	C	NA	NA	NA	NA	C	E
Route 107 NB - LT	NA	NA	NA	NA	NA	NA	B	C	B	C	B	C	B	C	B	C	NA	NA	NA	NA	B	B
Route 107 SB - RT	NA	NA	NA	NA	NA	NA	E	F	E	B	E	F	E	B	E	B	NA	NA	NA	NA	D	C
Route 107 SB - Through	NA	NA	NA	NA	NA	NA	C	C	C	C	C	C	C	C	C	C	NA	NA	NA	NA	C	D
Route 107 SB - LT	NA	NA	NA	NA	NA	NA	D	E	D	C	D	D	D	D	D	D	NA	NA	NA	NA	D	C
Upgraded - Route 1A SB at Route 145	B	B	B	B	B	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 145 WB - Through	A	A	A	A	A	A	A	A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 145 WB - LT	B	B	B	B	B	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 145 EB - Through	B	B	B	B	B	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 145 EB - RT	B	B	B	B	C	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upgraded - Route 1A NB at Route 145	B	B	B	B	B	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 145 WB - Through	B	B	B	B	B	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Route 145 EB - Through	B	B	B	B	B	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LT from NB Route 1A off-ramp	B	B	B	B	B	B	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RT from NB Route 1A off-ramp	B	C	B	C	B	C	B	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

F*: Volume-to-capacity ratio (v/c) > 1.2; delay could not be reasonably estimated.
NA: Not Applicable.

Brown Circle

CTPS evaluated replacement of the existing Brown Circle with a fully signalized intersection. Left turns, through movements, and right turns would be allowed from all approaches (Figure 4-14). As analyzed, there would be two left-turn and two through lanes at the approaches of eastbound and westbound Route 60 and southbound Route 107, and only one of each at the northbound Route 107 approach. Such an intersection would operate at LOS D or better under all the packages that include it (Packages 4 through 8A and Package 9). A free right turn is necessary from Route 60 westbound to Route 107 northbound and from Route 107 southbound to Route 60 westbound in most of the packages.

It also should be noted that all the packages that include Brown Circle signalized also include improved connections between Routes 1 and 16 and between Routes 1A and 16. This diverts sufficient future traffic from Route 60. In the packages in which these connections are not improved (Packages 1 and 2), Brown Circle is grade-separated in order to accommodate the predicted future traffic volumes.

Analysis of the Recommended Package (Package 9)

The selection of individual long-range alternatives for the recommended package was based on the above analyses and on discussions with TAC members and operating agencies on the feasibility of each alternative. The package consists of Alternative 2 Revised for the Route 1/16 interchange, Alternative 4 for Route 1A/16, Alternative 3 for Route 1 north of Copeland Circle, the Route 1A/Chelsea Street Bridge connection, and signalization of Brown Circle. As with Packages 4 to 8C, Package 9's approach to improving connections between Routes 1 and 1A utilizes Route 16 as the primary link. The general effects on travel patterns that are described at the beginning of the section above on Packages 4 to 8C would also ensue from Package 9. The predicted impacts of the package on traffic volumes and on volume-to-capacity ratios are summarized below.

Difference in traffic volumes in the peak direction, compared to 2020 no-build base case:

- Route 60 between Copeland and Brown circles (Revere)
  - AM peak hour: Approx. 40% decrease
  - PM peak hour: Approx. 25% decrease
- Route 60 between Mahoney and Brown circles (Revere)
  - AM peak hour: Approx. 20% decrease
  - PM peak hour: Approx. 40% decrease
- Route 16 west of Route 1 (Chelsea/Everett)
  - AM peak hour: Approx. 30% decrease
  - PM peak hour: Approx. 25% decrease
- Route 16 between Route 1 and Route 107 (Chelsea/Revere)
  - AM peak hour: Approx. 70% increase
  - PM peak hour: Approx. 35% increase
- Route 1 between Copeland Circle and Route 16 (Revere/Everett)
  - AM peak hour: Approx. 15% increase
  - PM peak hour: Approx. 20% increase
- Route 1A south of Route 16 (Revere/East Boston)
  - AM peak hour: Approx. 15% increase
  - PM peak hour: Approx. 15% increase

- Route 1A north of Mahoney Circle (Revere)
  - AM peak hour: Approx. 10% decrease
  - PM peak hour: Approx. 5% decrease
- Route 107 south of Brown Circle (Revere)
  - AM peak hour: Approx. 30% decrease
  - PM peak hour: Approx. 40% decrease
- Route 107 north of Route 16 (Revere)
  - AM peak hour: Approx. 10% increase
  - PM peak hour: Approx. 25% decrease
- Revere Beach Parkway east of Route 1A (Revere)
  - AM peak hour: Approx. 90% decrease
  - PM peak hour: Approx. 90% decrease

The predicted traffic volumes on major roadways under Package 9 were also examined to see if they would exceed the roadway's estimated capacities. It was found that all the roadways' volume-to-capacity (v/c) ratios would be expected to be under 1.0, except that Route 1 between Copeland Circle and Route 16 in the AM and PM peak hours and Route 107 just north of Route 16 in the AM peak hour would have a v/c ratio of 1.0. The v/c ratios calculated for the major roadways are summarized below. This preliminary analysis indicated that the major roadways in the study area would be able to handle the predicted traffic volumes.

V/c ratios calculated for major roadways, 2020, based on predicted traffic volumes and estimated roadway capacities:

- Route 60 between Copeland and Brown circles (Revere)
  - AM peak hour: 0.55
  - PM peak hour: 0.85
- Route 60 between Mahoney and Brown circles (Revere)
  - AM peak hour: 0.90
  - PM peak hour: 0.65
- Route 16 west of Route 1 (Chelsea/Everett)
  - AM peak hour: 0.60
  - PM peak hour: 0.75
- Route 16 between Route 1 and Route 107 (Chelsea/Revere)
  - AM peak hour: 0.60
  - PM peak hour: 0.75
- Route 1 between Copeland Circle and Route 16 (Revere/Everett)
  - AM peak hour: 1.00
  - PM peak hour: 1.00
- Route 1A south of Route 16 (Revere/East Boston)
  - AM peak hour: 0.90
  - PM peak hour: 0.70
- Route 1A north of Mahoney Circle (Revere)
  - AM peak hour: 0.85
  - PM peak hour: 0.85

- Route 107 south of Brown Circle (Revere)
  - AM peak hour: 0.40
  - PM peak hour: 0.35
- Route 107 north of Route 16 (Revere)
  - AM peak hour: 1.00
  - PM peak hour: 0.95
- Revere Beach Parkway east of Route 1A (Revere)
  - AM peak hour: 0.10
  - PM peak hour: 0.15

Figure 5–2
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 1

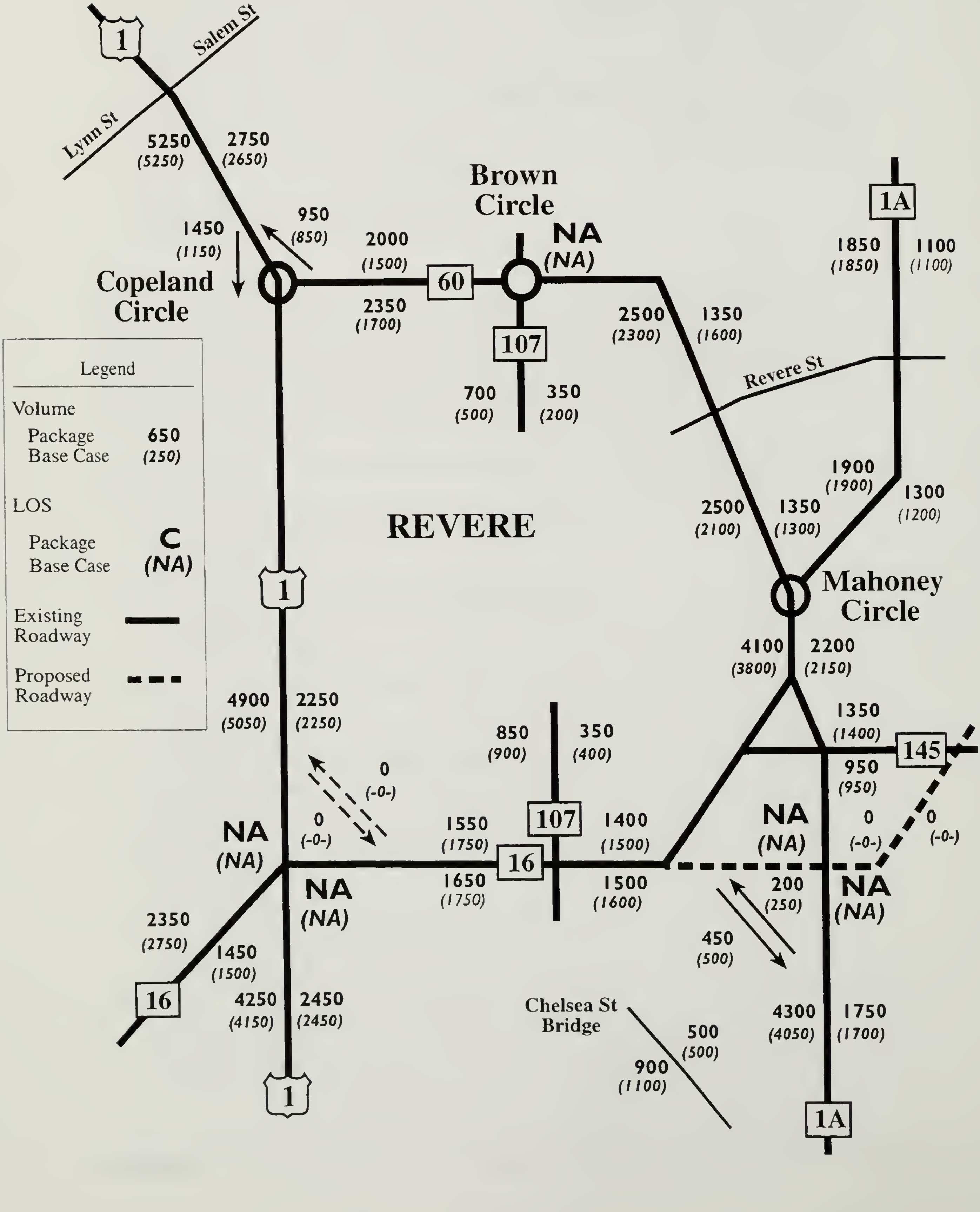


Figure 5–3
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 1

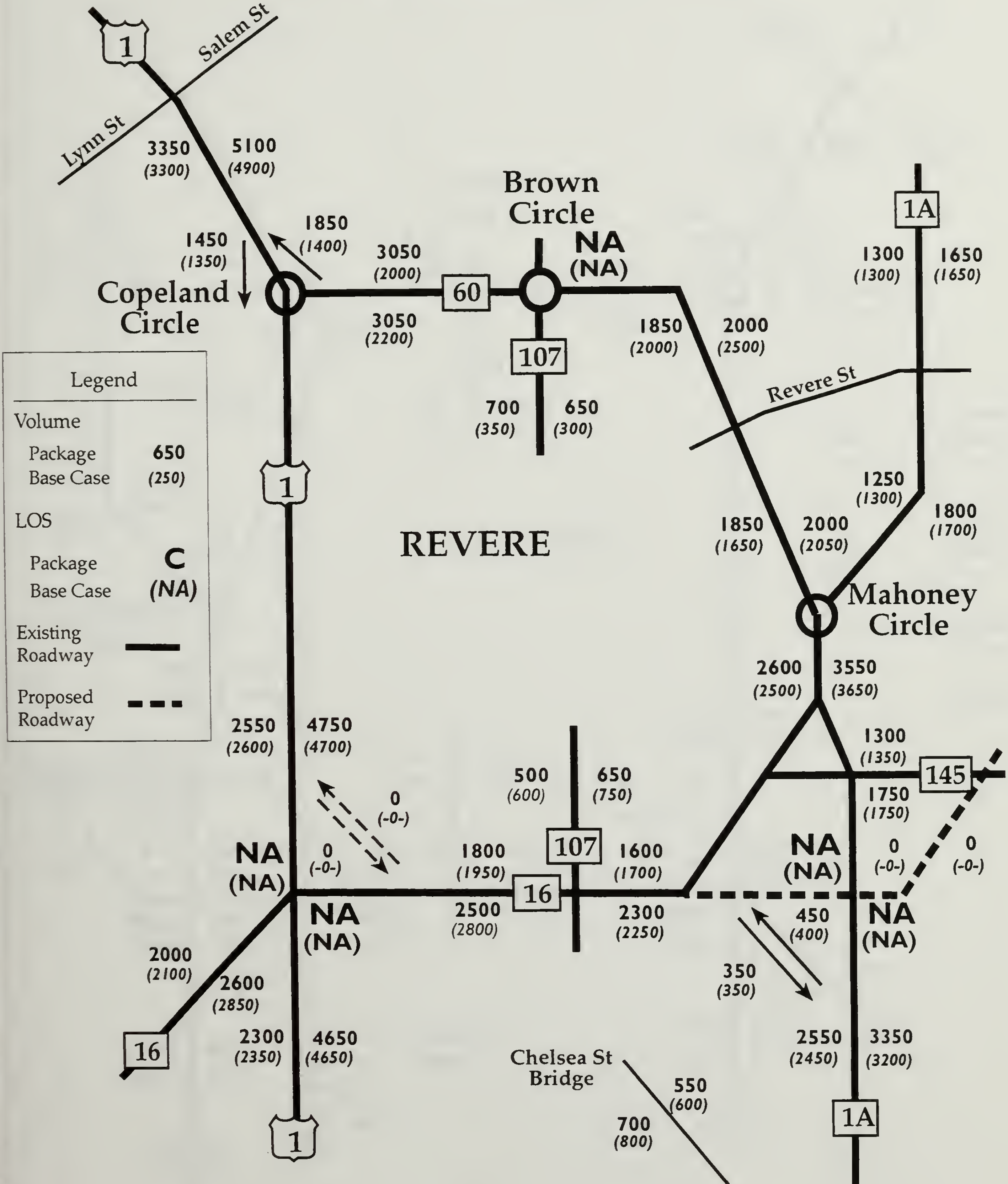


Figure 5-4
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 2

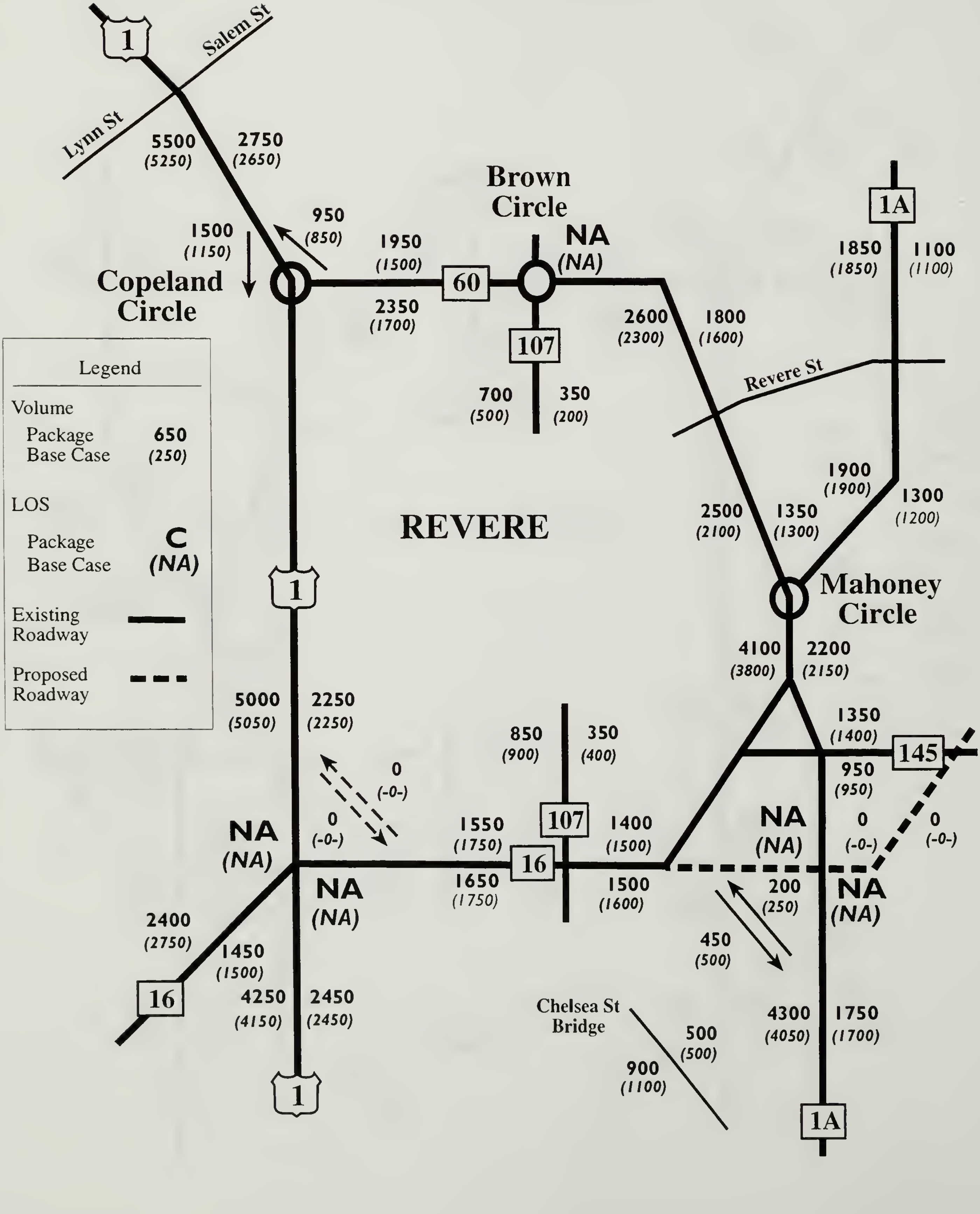


Figure 5–5
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 2

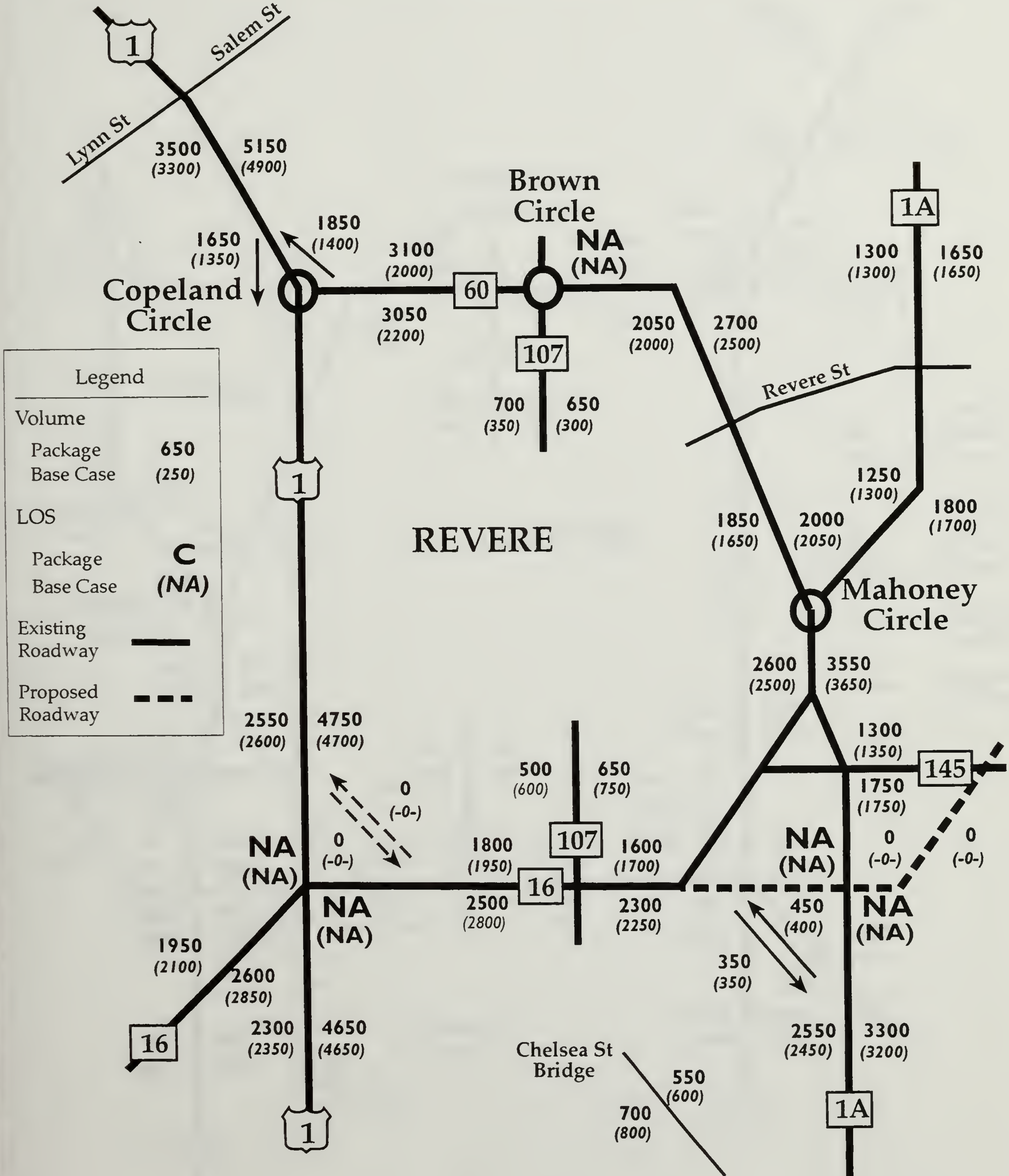


Figure 5–6
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 3

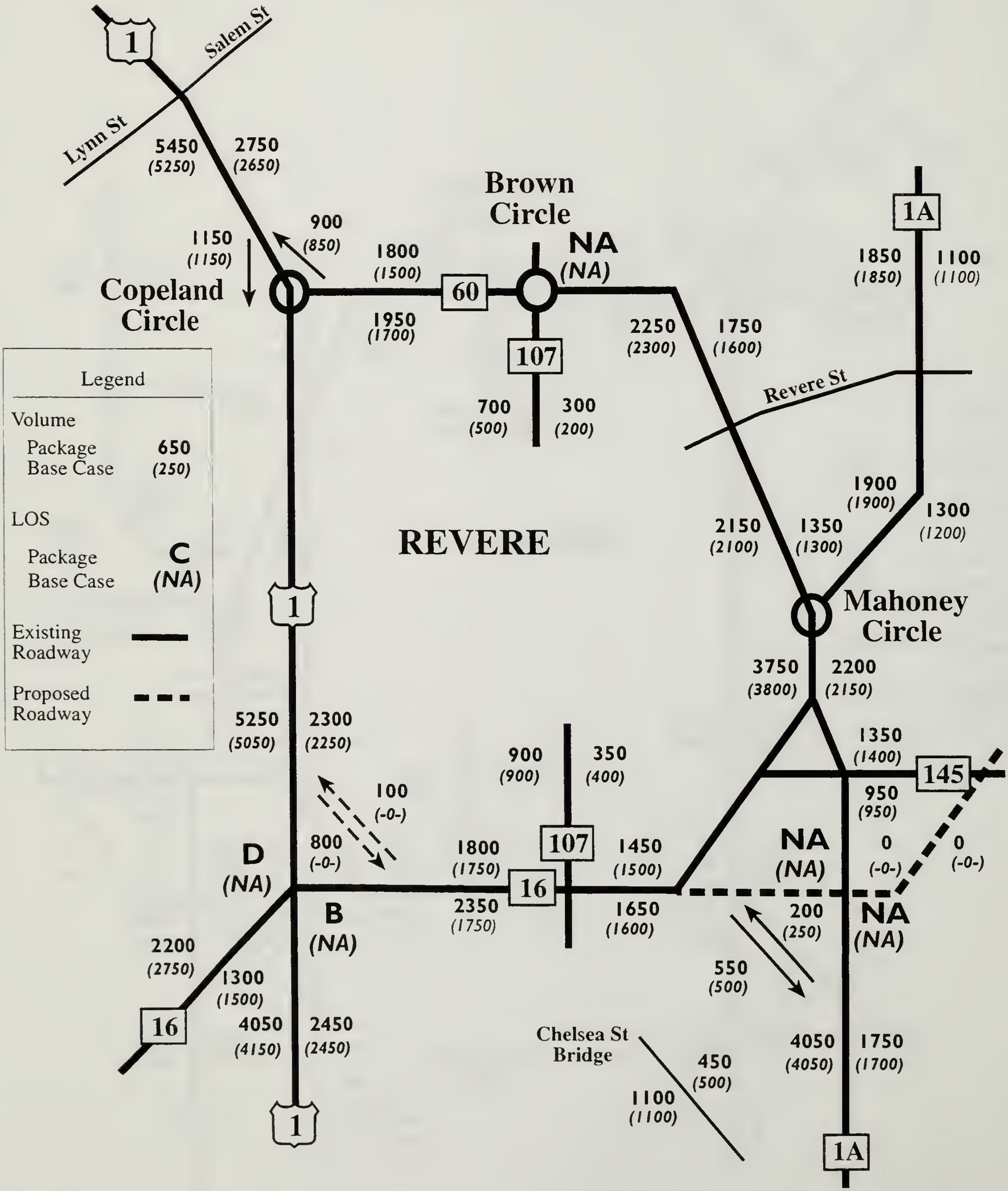


Figure 5–7
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 3

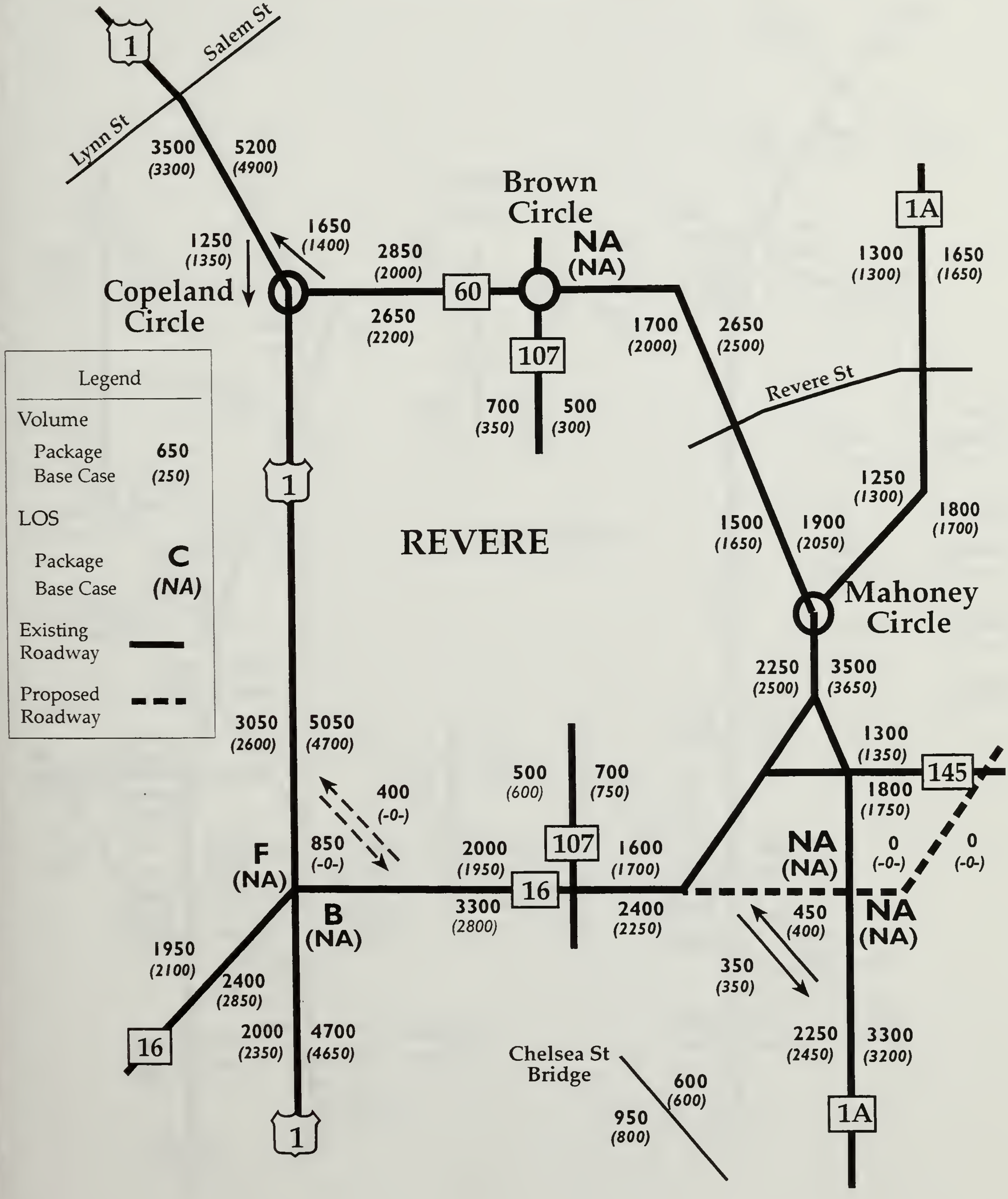


Figure 5–8
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 4

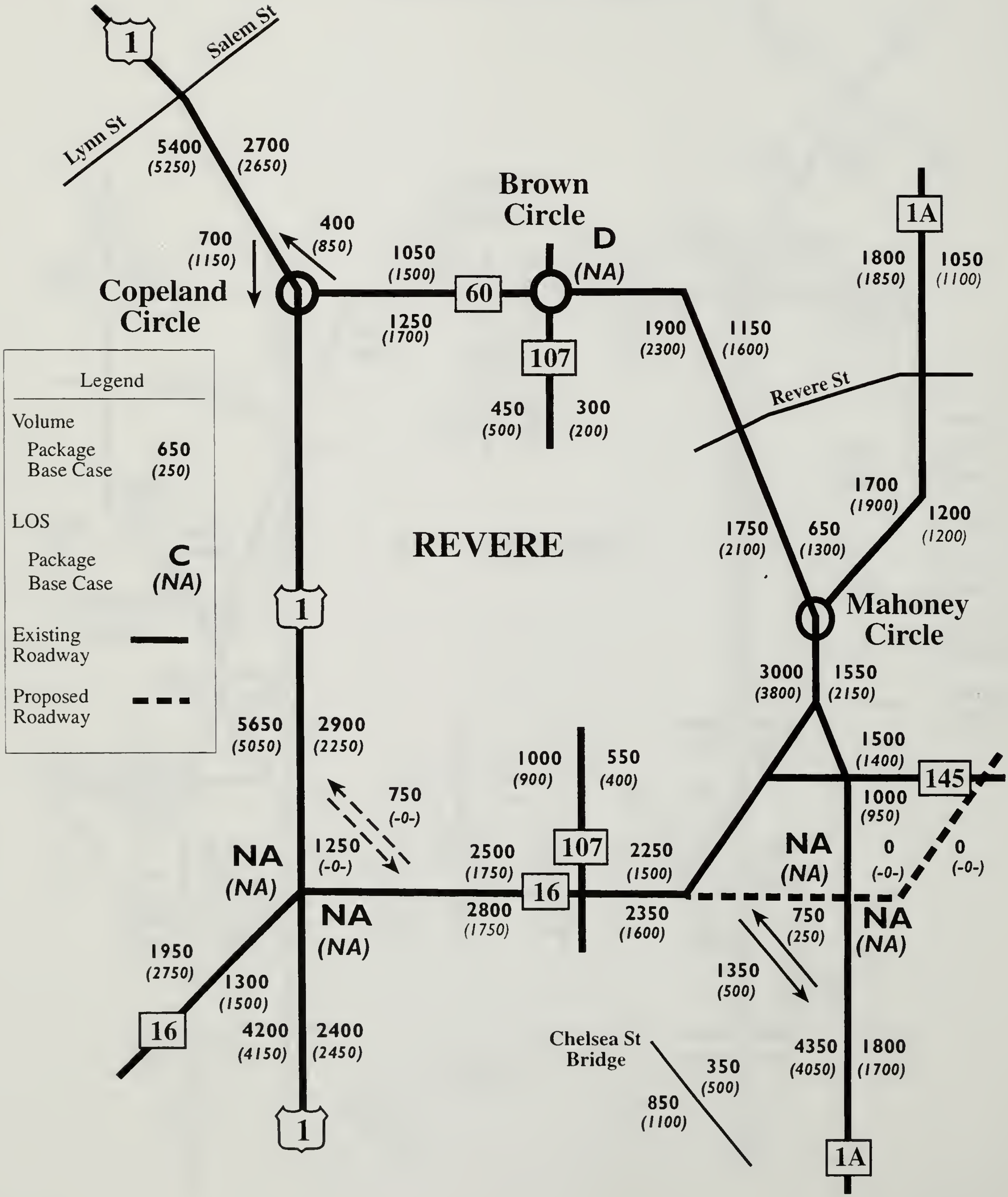


Figure 5–9
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 4

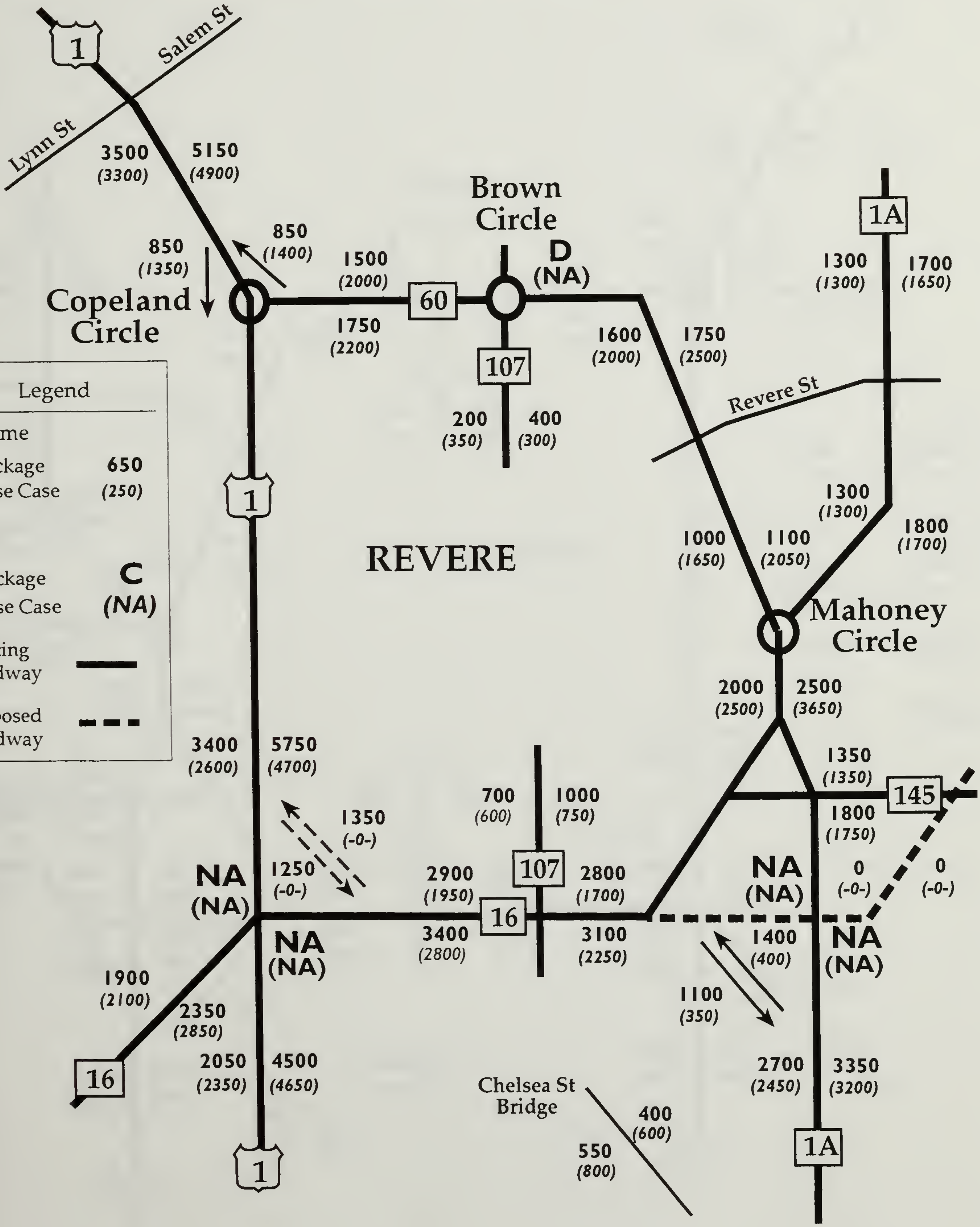


Figure 5–10
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 5

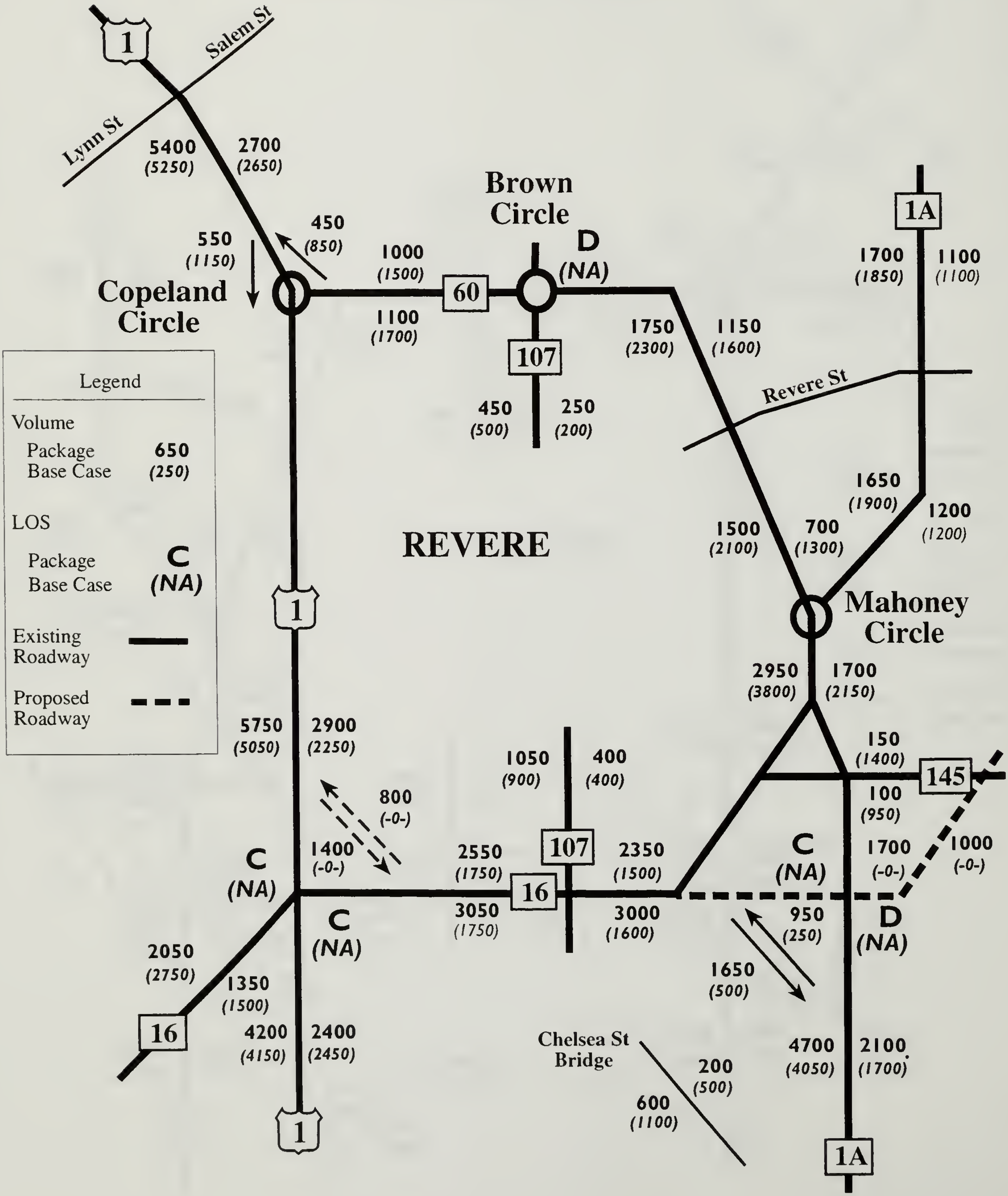


Figure 5–11
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 5

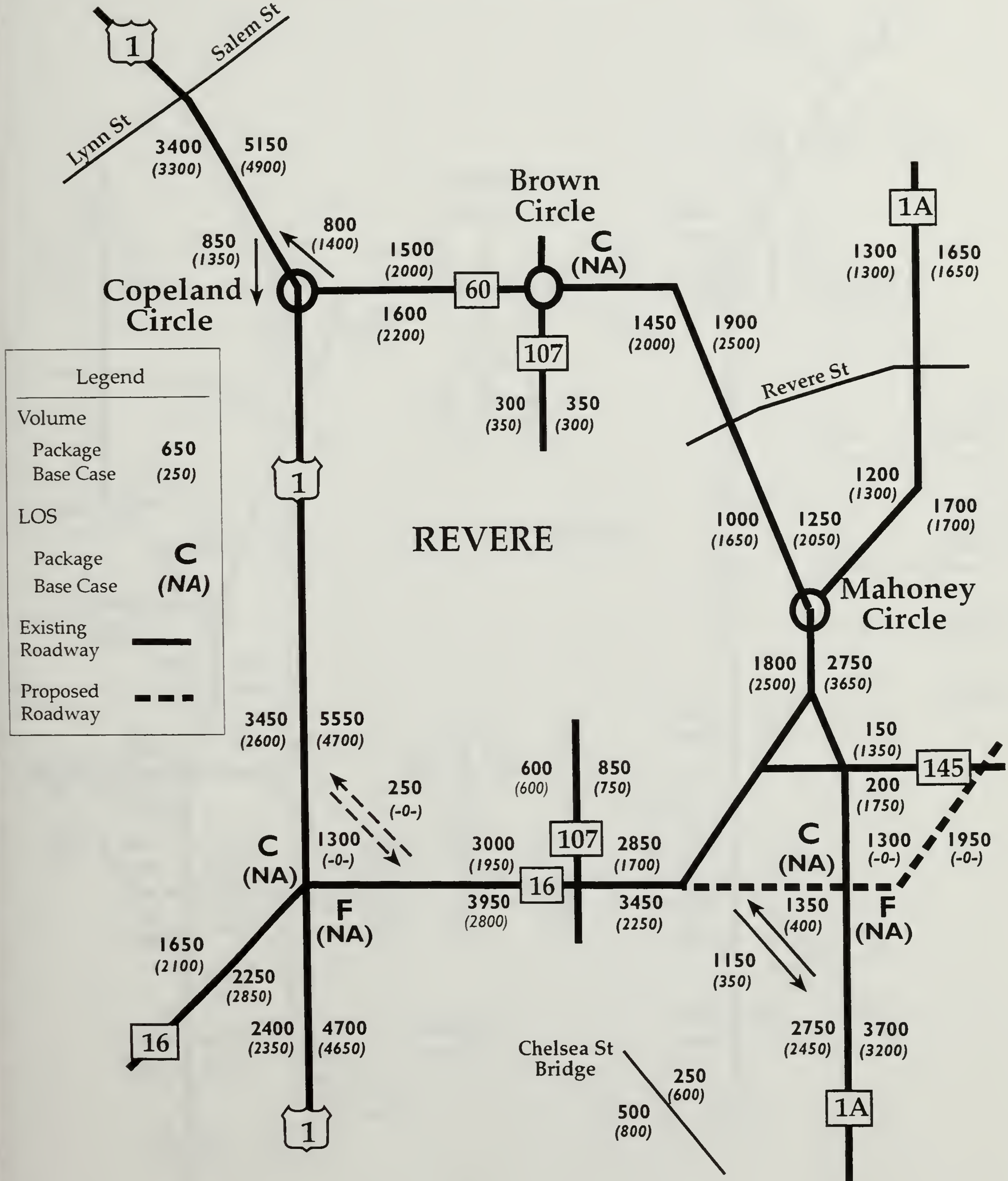


Figure 5–12
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 6

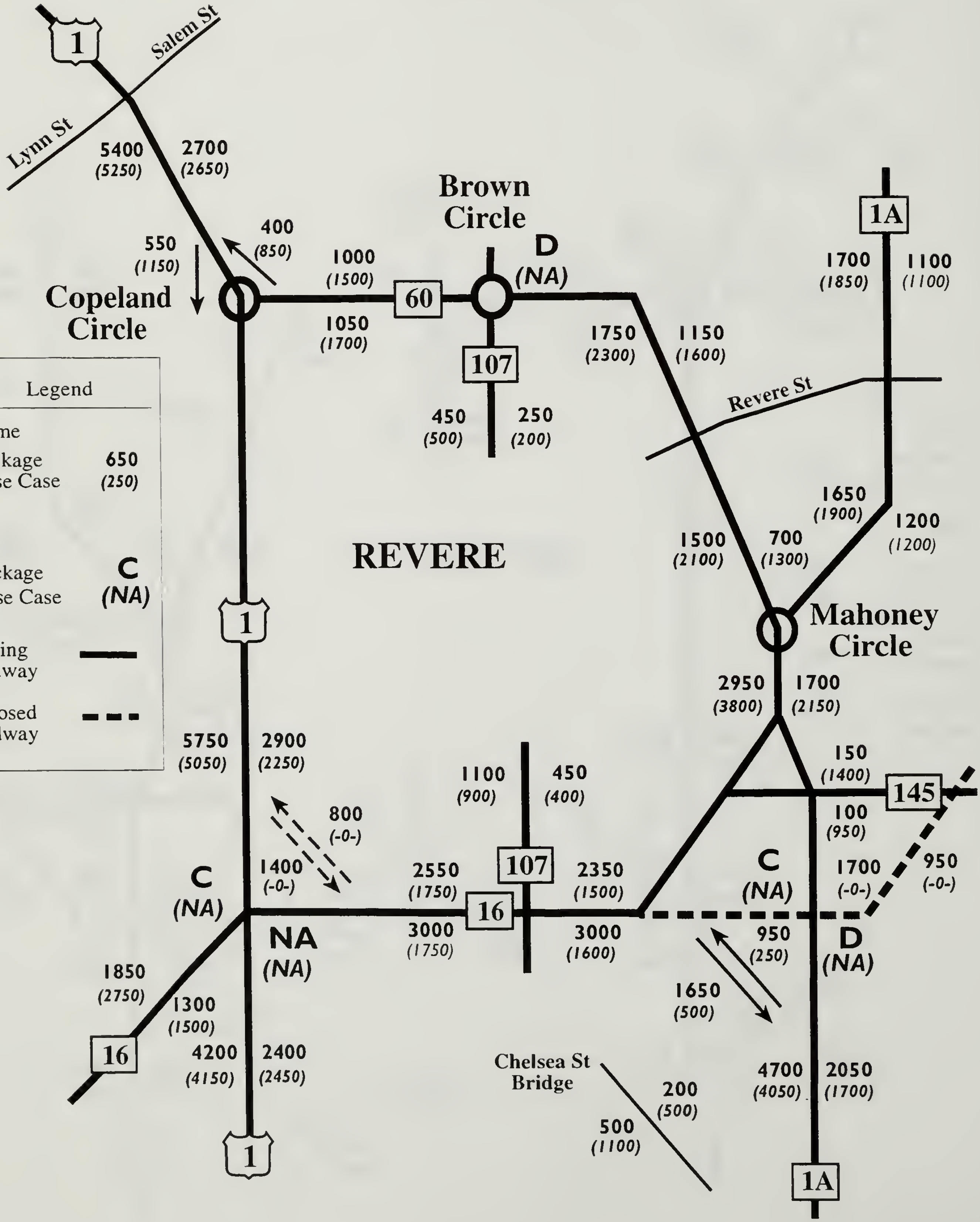


Figure 5–13
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 6

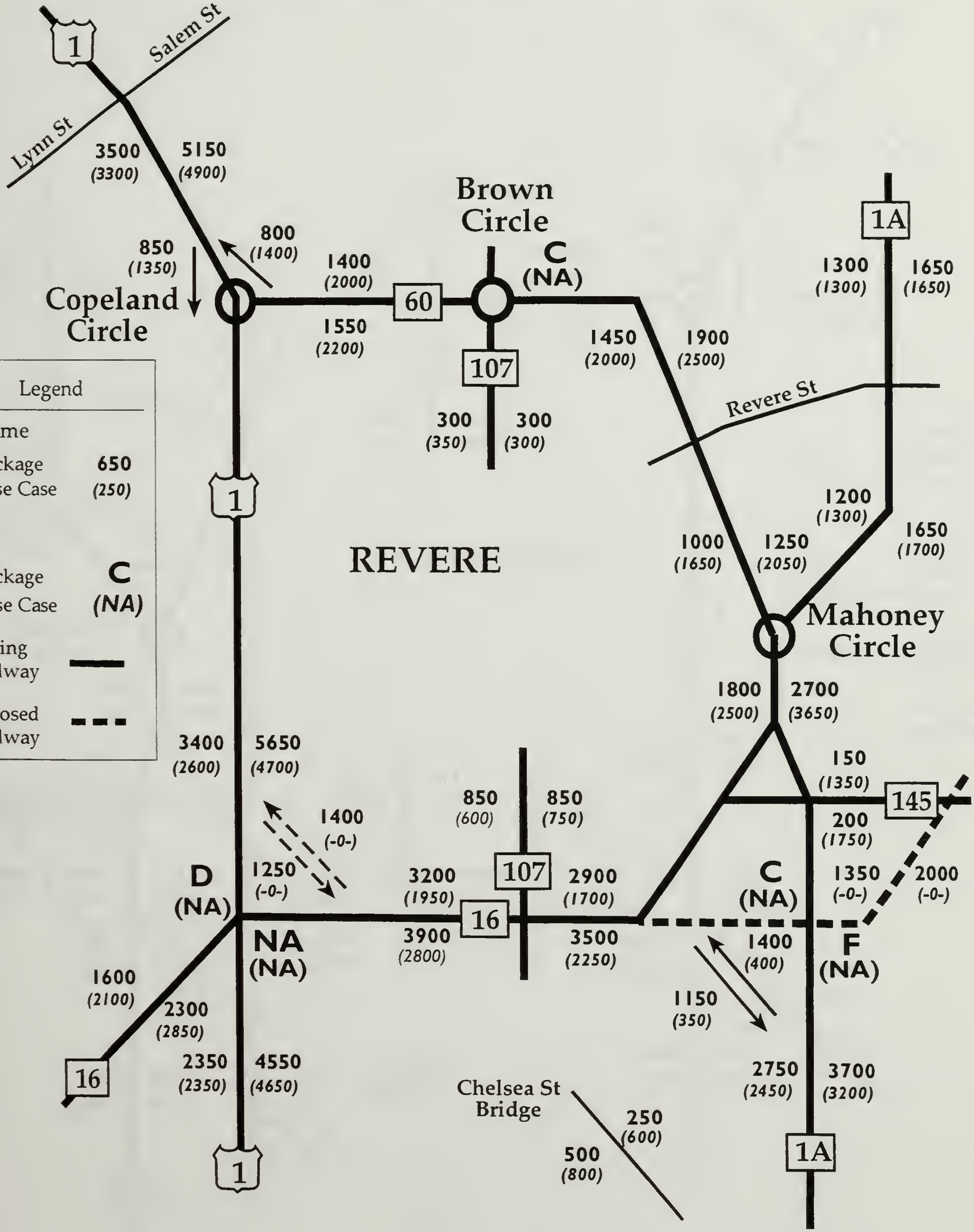


Figure 5–14
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 7

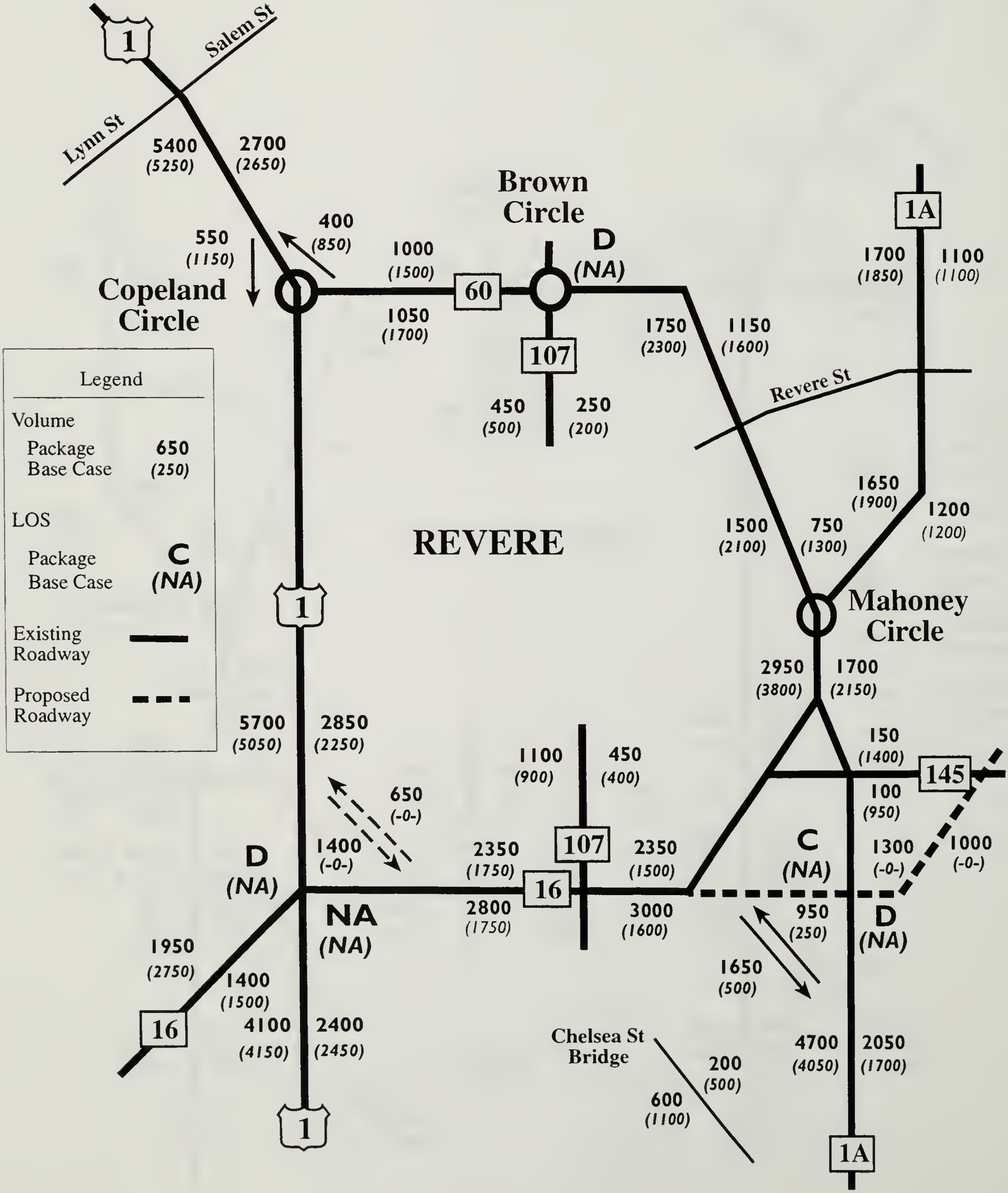


Figure 5–15
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 7

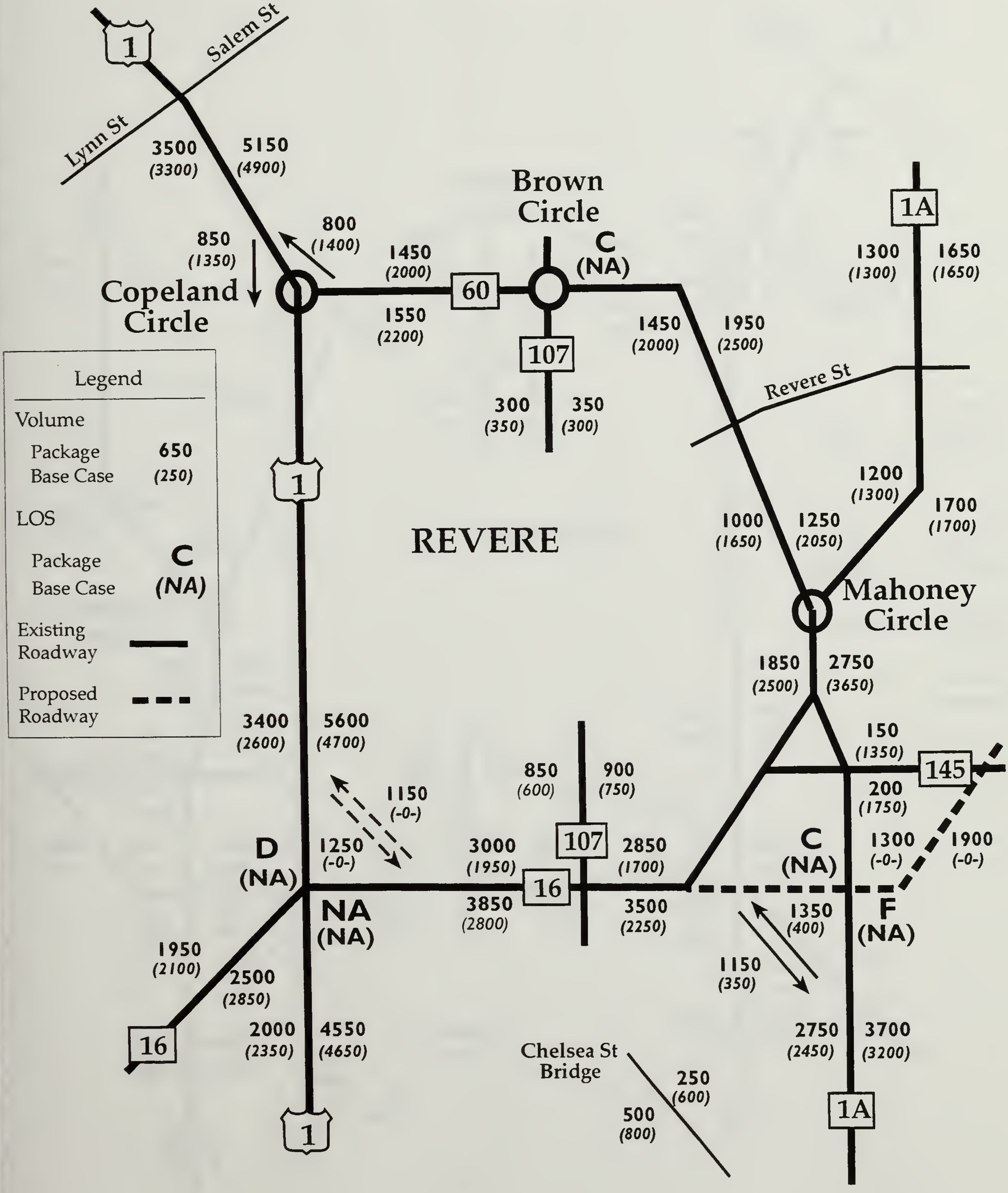


Figure 5–16
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 8A

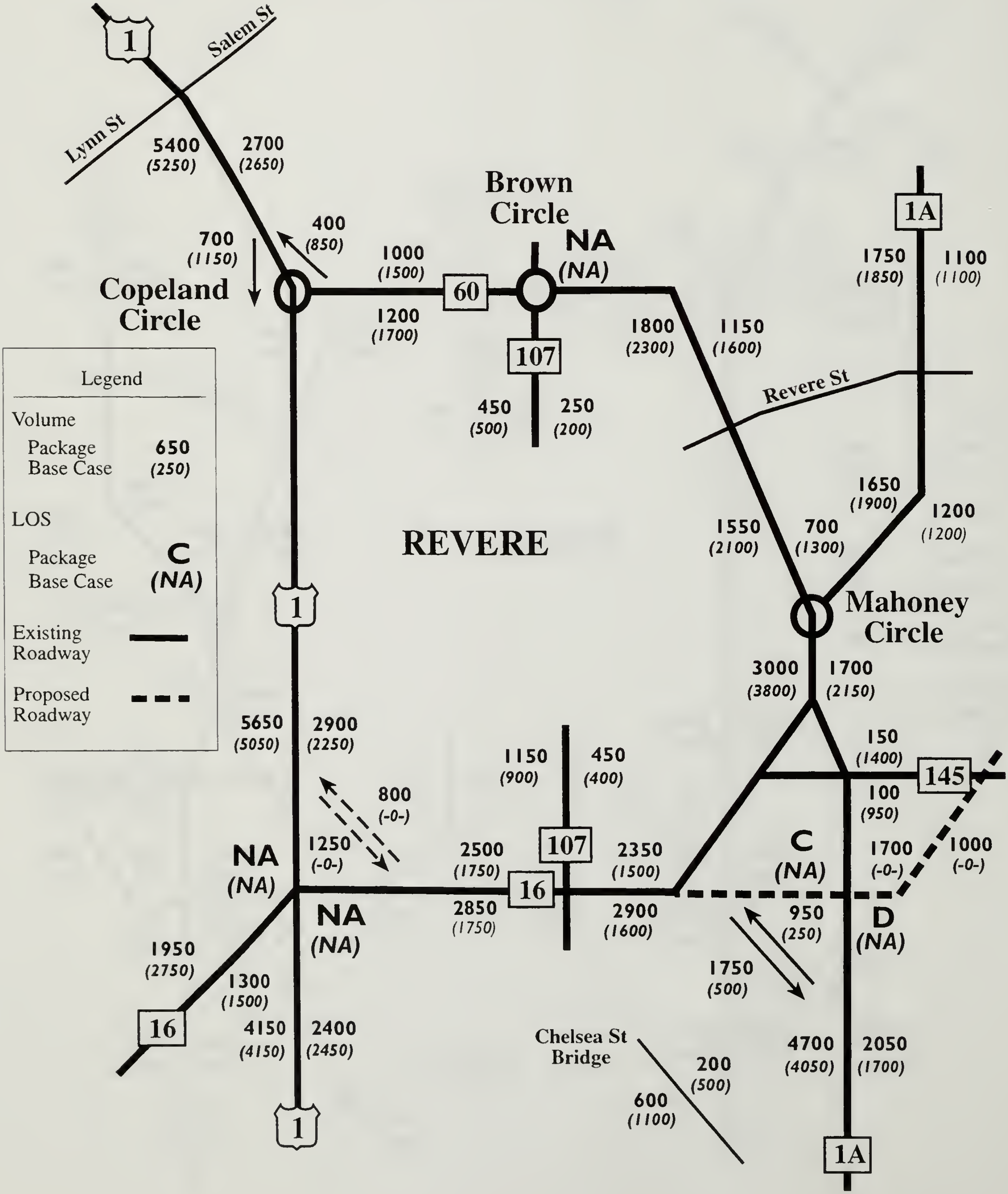


Figure 5–17
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 8A

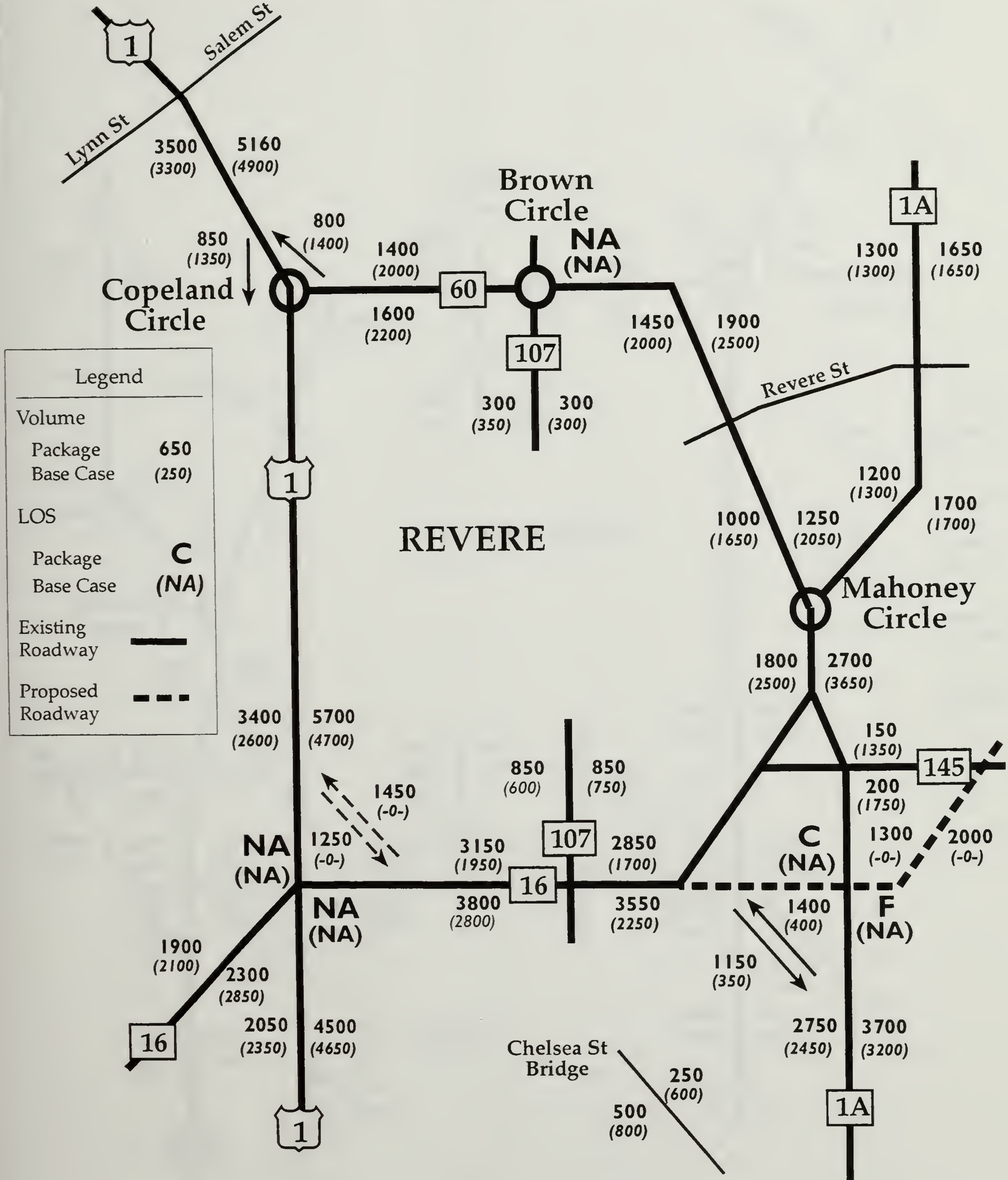


Figure 5–18
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 8B

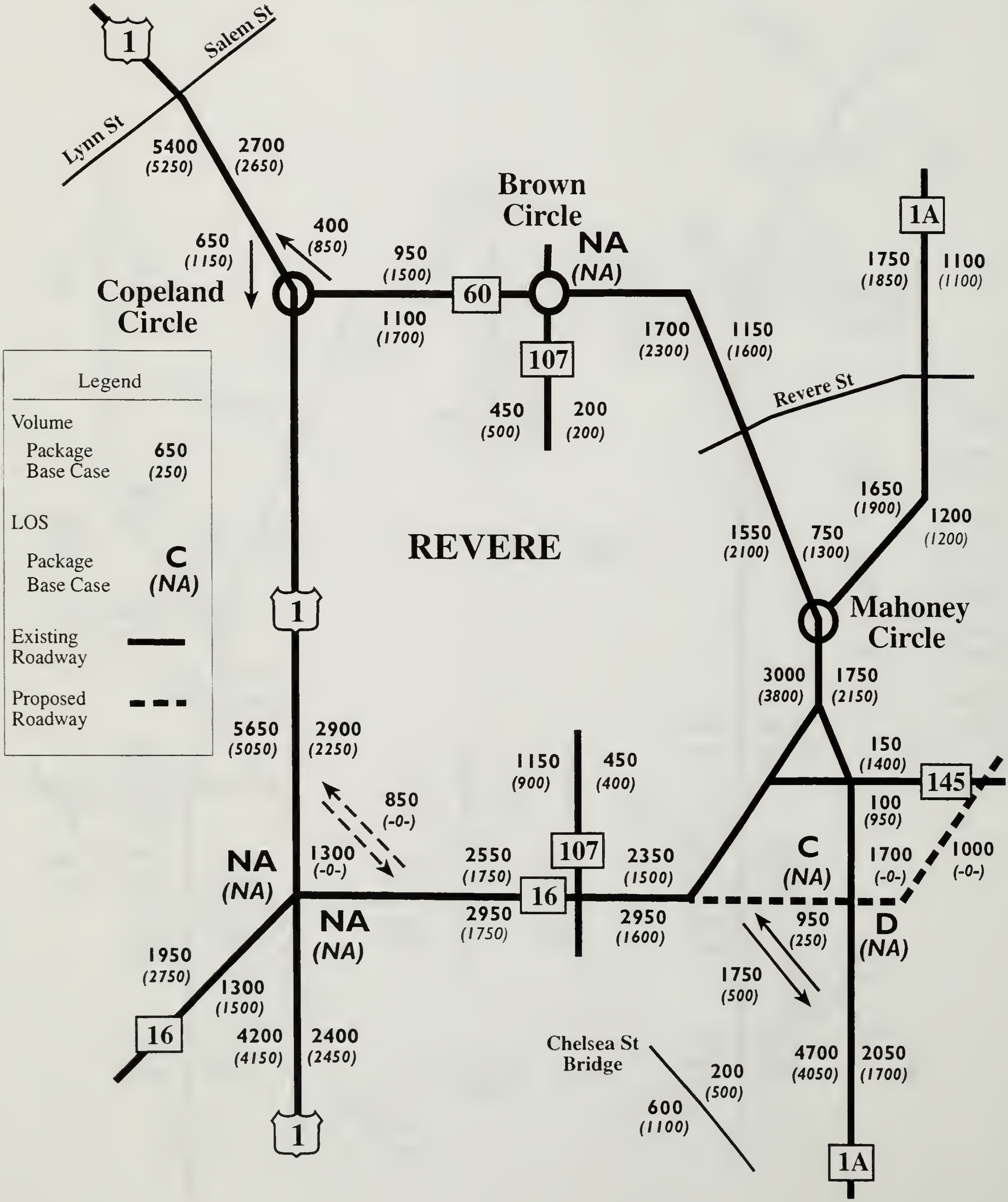


Figure 5–19
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 8B

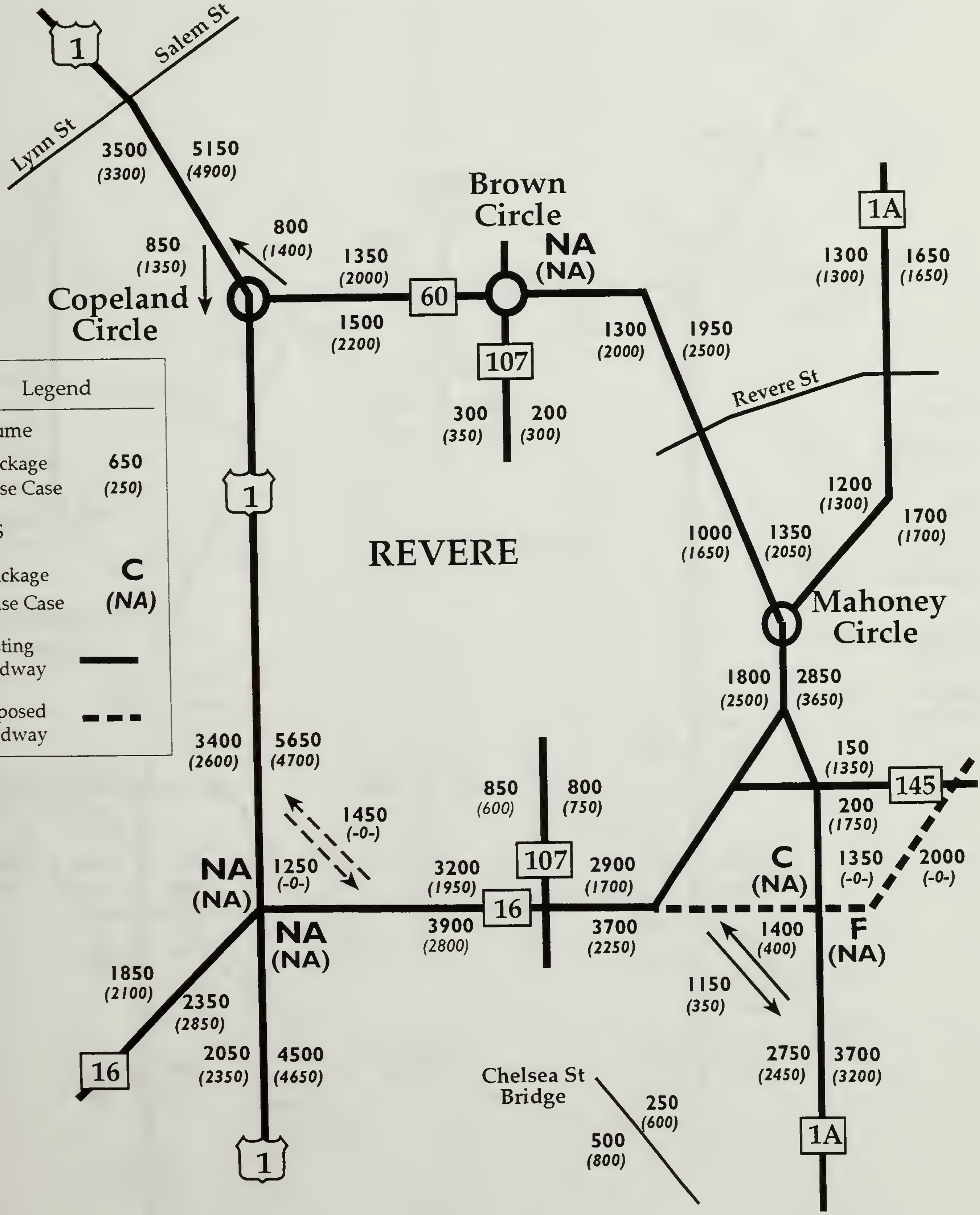


Figure 5–20
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 8C

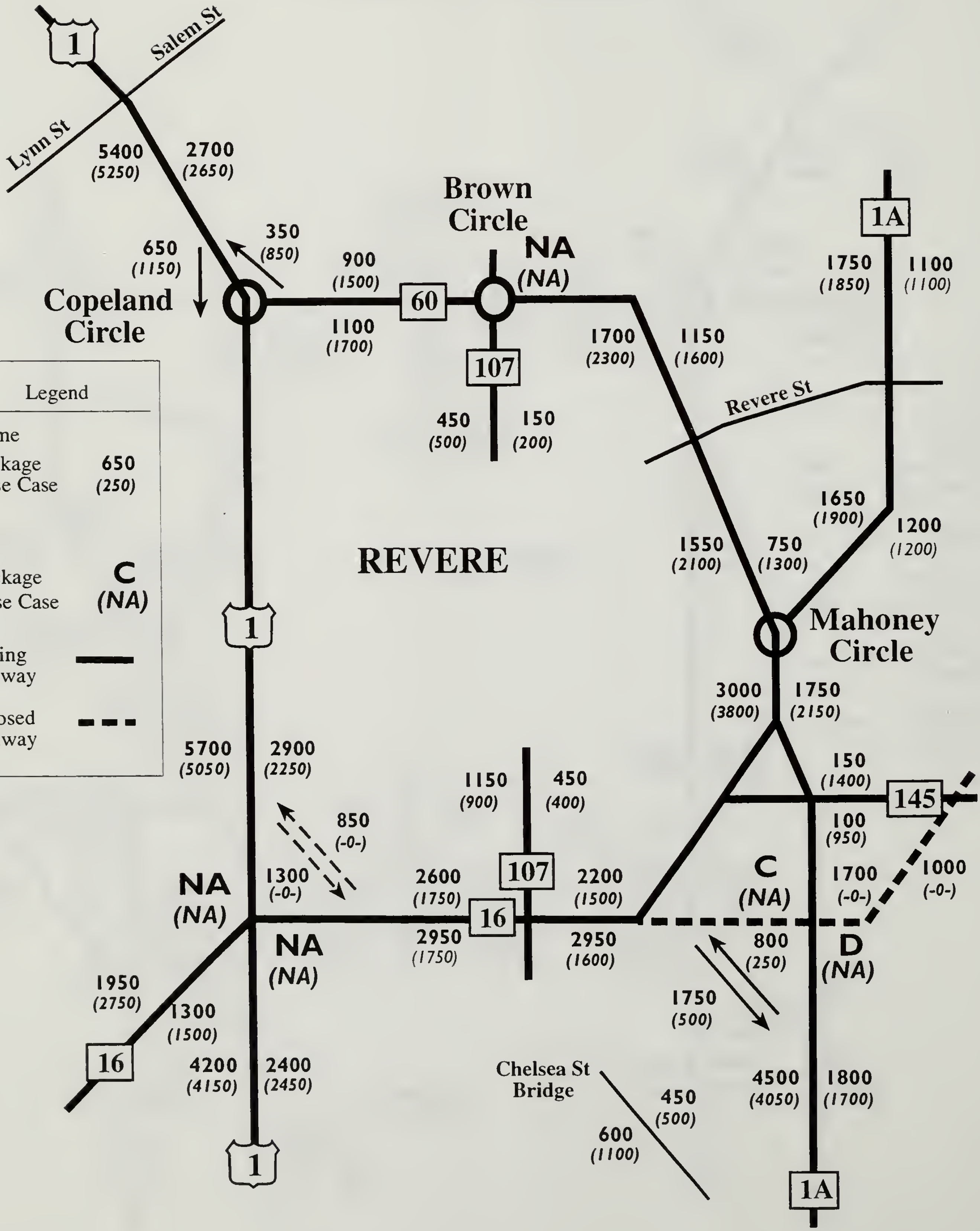


Figure 5–21
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 8C

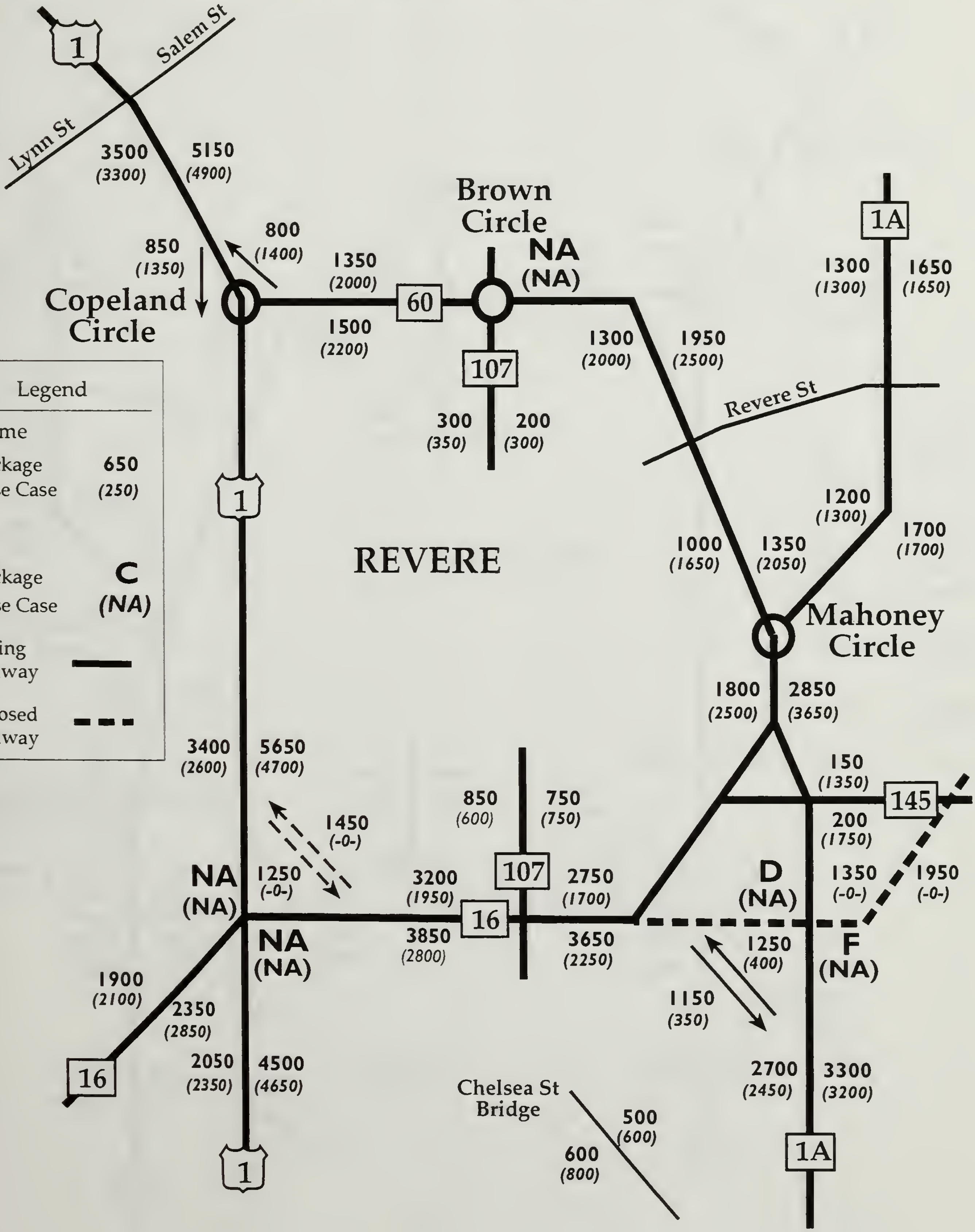


Figure 5–22
TrafficVolumes and LOS, Year 2020
AM Peak Hour, Package 9

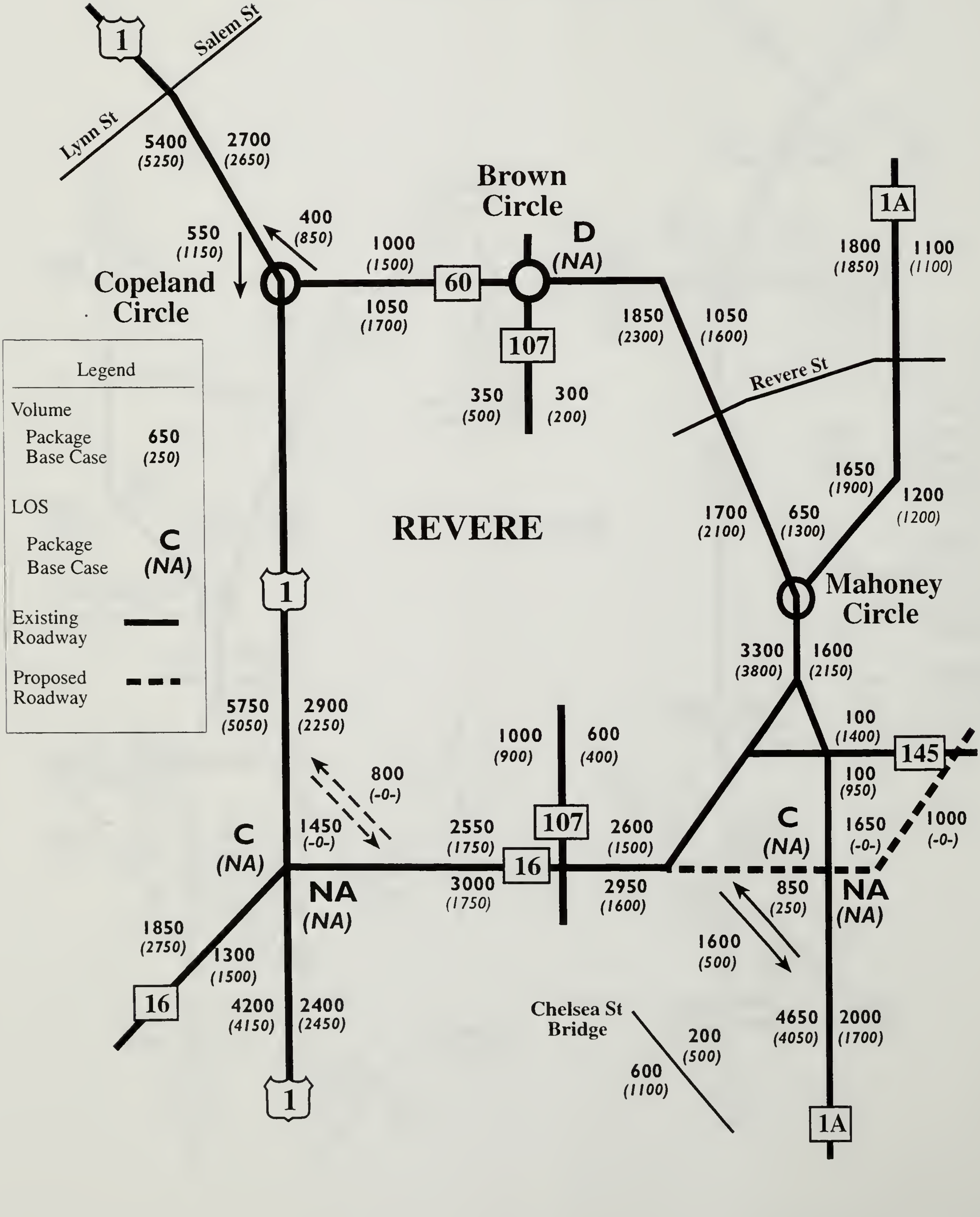
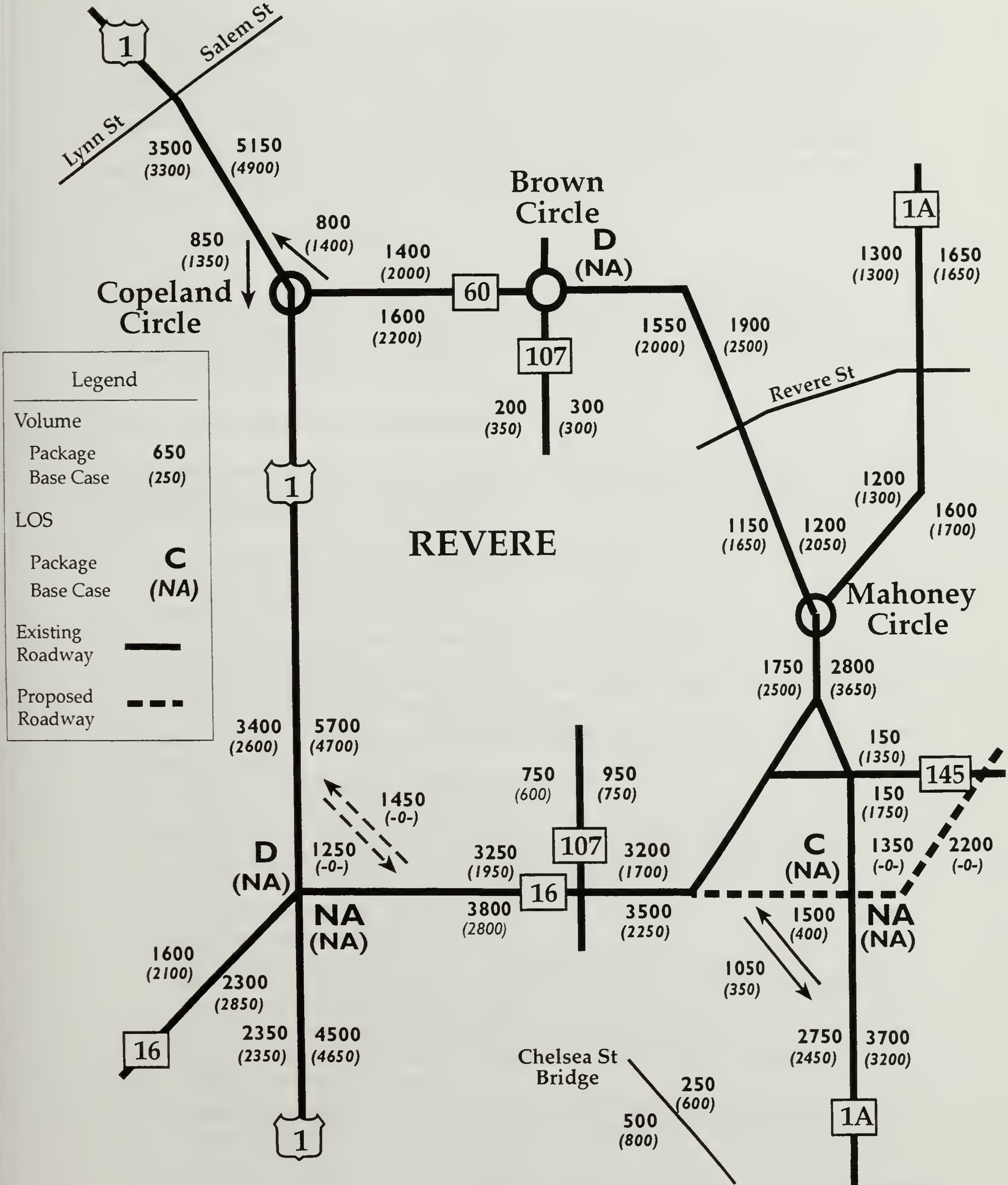


Figure 5–23
Traffic Volumes and Level of Service (LOS), Year 2020
PM Peak Hour, Package 9



6 RECOMMENDATIONS

This chapter presents this study's recommendations regarding transportation improvements for the study area. These recommendations are based on analyses of the various alternatives and on discussions with the TAC members, the general public, and the operating agencies. They are presented in two categories: short-range and long-range improvements. Also included in this chapter is an outline of future implementing procedures for improvements. It should be noted that the improvements recommended in this report are generally conceptual only and would all be subject to further engineering study, community consensus–building, and any required environmental reviews prior to implementation.

6.1 Short-Range Improvements

The short-range improvements recommended for the various locations include traffic management strategies, traffic signal retiming, geometric improvements to intersections, pedestrian safety improvements, and other traffic improvement measures. The following sections summarize for each location the main points of the improvements being recommended. For more detailed descriptions, see chapter 3.

6.1.1 Hancock Street Traffic Management, Everett

Three alternatives were developed during the course of this study, each building on the previous one. The final set of recommended measures, presented below and shown in Figure 6-1, favors Alternative 3's set, with a few modifications.

- Provide contrasting crosswalks (for example, green painted)
  - Makes crosswalks more prominent
  - Reminds motorists to slow down
- Convert High Street from one-way eastbound to one-way westbound
  - Prevents cut-through traffic
  - Improves traffic flow on Broadway by eliminating interlocking left-turn queues formed by left turns into Hancock Street and High Street
- Prohibit parking around Raymond MacKinnon Square; relocate parking to eastbound side of Gilmore Street
  - Improves recreational use of attractive open space
  - Clears space for fire trucks pulling in and out
- Alternate parking on northbound and southbound sides of Hancock Street
  - Discourages speeding by visually interrupting the continuity of the roadway
  - Maintains about the same number of parking spaces
- Provide bulb-outs and relocate signal posts
  - Improves visibility of traffic signals
  - Encourages motorists to slow down and prepare to react
  - Shortens pedestrian crossing distances, provides protected parking bays, and decreases vehicle speeds by narrowing the roadway
- Narrow Hancock Street (expand sidewalk) through commercial area
  - Encourages slow speeds through the commercial area and on the approaches
  - Helps promote area businesses
- Give distinctive appearance to sidewalks in commercial area (for example, brick)
  - Encourages motorists to slow down by creating a "downtown" appearance

- Convert the signalized intersection at Belmont Street to a traffic circle
  - Discourages speeding upon entering Everett
  - Serves as gateway and can be used to welcome visitors to Everett

It should be noted that the recommendation of a traffic circle at Belmont Street is a conceptual proposal that requires further study with respect to geometry, traffic volume, and other factors. Also, since the intersection is located in the city of Malden, that city's support would be needed for further development of this concept.

6.1.2 Revere Beach Boulevard Traffic Management, Revere

The following set of improvements is recommended for Revere Beach Boulevard (RBB) in Revere (Figure 6-2). This recommendation received many favorable responses at the public meetings.

- At all gateways narrow roadway and install sign, "Entering Recreational Area: Drive Carefully"
  - Discourages speeding when entering RBB
  - Warns motorists that they are entering a special traffic management area
- Provide neckdowns at pedestrian crossing areas; make crosswalks more prominent; install "Cross Only at Crosswalk" signs
  - Helps motorists and pedestrians see one another better
  - Encourages pedestrians to cross at appropriate locations
  - Shortens pedestrian crossing distances
- Convert angle parking to parallel and extend sidewalk north of Revere Street
  - Enhances recreational activities along the entire beach
- Extend MBTA bus route(s) with stops located on RBB north of Oak Island Street
  - Provides transportation for the Point of Pines area and the boulevard residents
  - Potentially reduces traffic volumes along the corridor

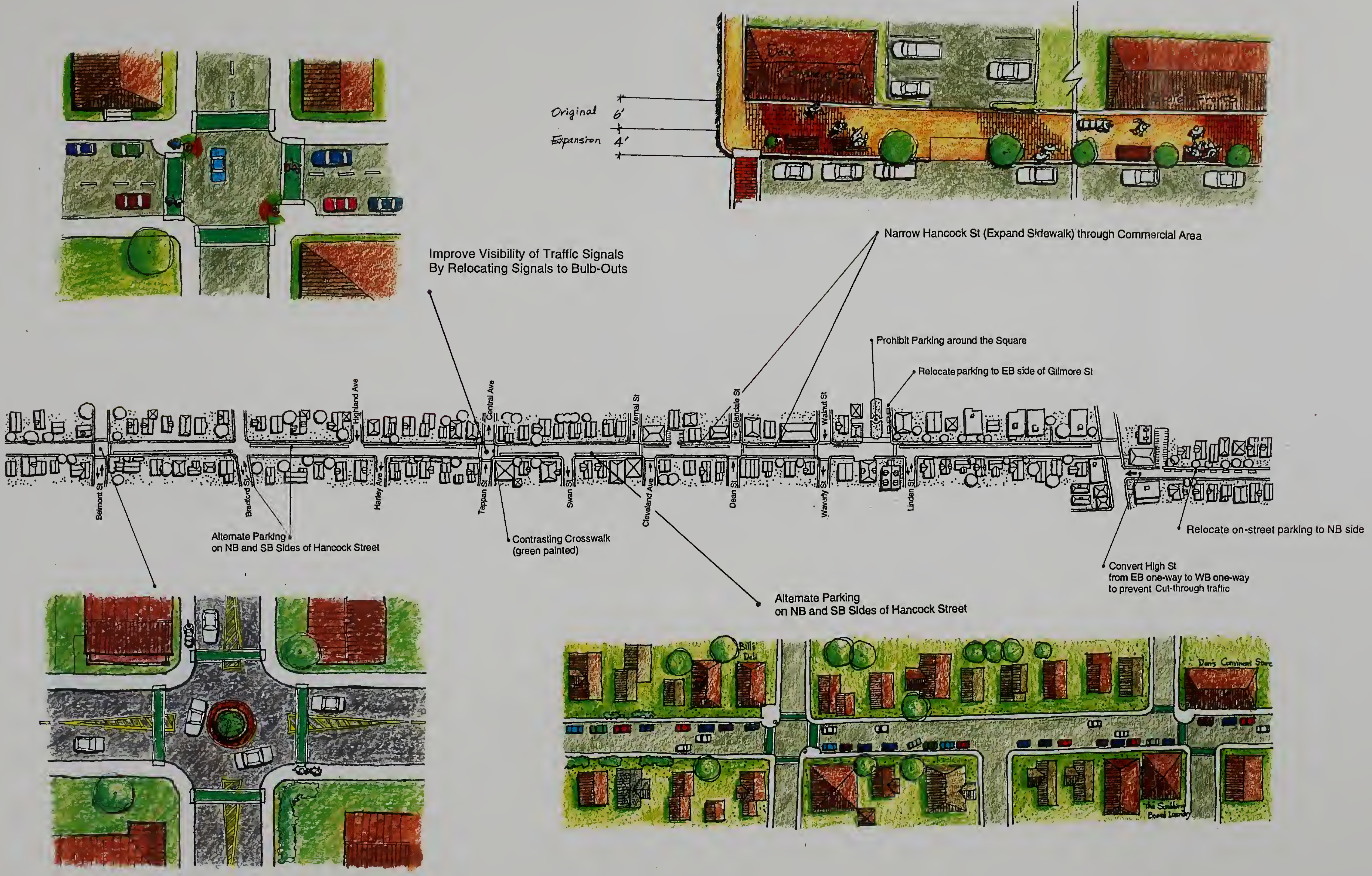
6.1.3 Congested Signalized Intersections

Traffic signal retiming and, in some cases, a signal system upgrade or geometric improvements are recommended for the following intersections in the study area.

1) Bennington Street at Saratoga Street, East Boston

Signal timing adjustments alone will not solve existing problems at this intersection. Either additional lanes (Alternative 1) or shifts in traffic patterns (Alternative 2) are necessary to achieve congestion and safety benefits. Alternative 1 is the recommended improvement. It adds lanes through on-street parking reductions.

- Eliminate curb parking within 600 feet of the intersection
- Provide a left-turn lane on Bennington Street at both approaches
- Provide a right-turn lane on northbound Bennington Street
- Add a lane to eastbound Saratoga Street
- Reduce westbound Saratoga Street to two lanes, while giving an extra lane to the eastbound Saratoga Street departure



Convert the Traffic Signal at Belmont St to a Traffic Circle
(Concept Sketch)

Figure 6-1
Recommended Improvements
Hancock Street Traffic Management

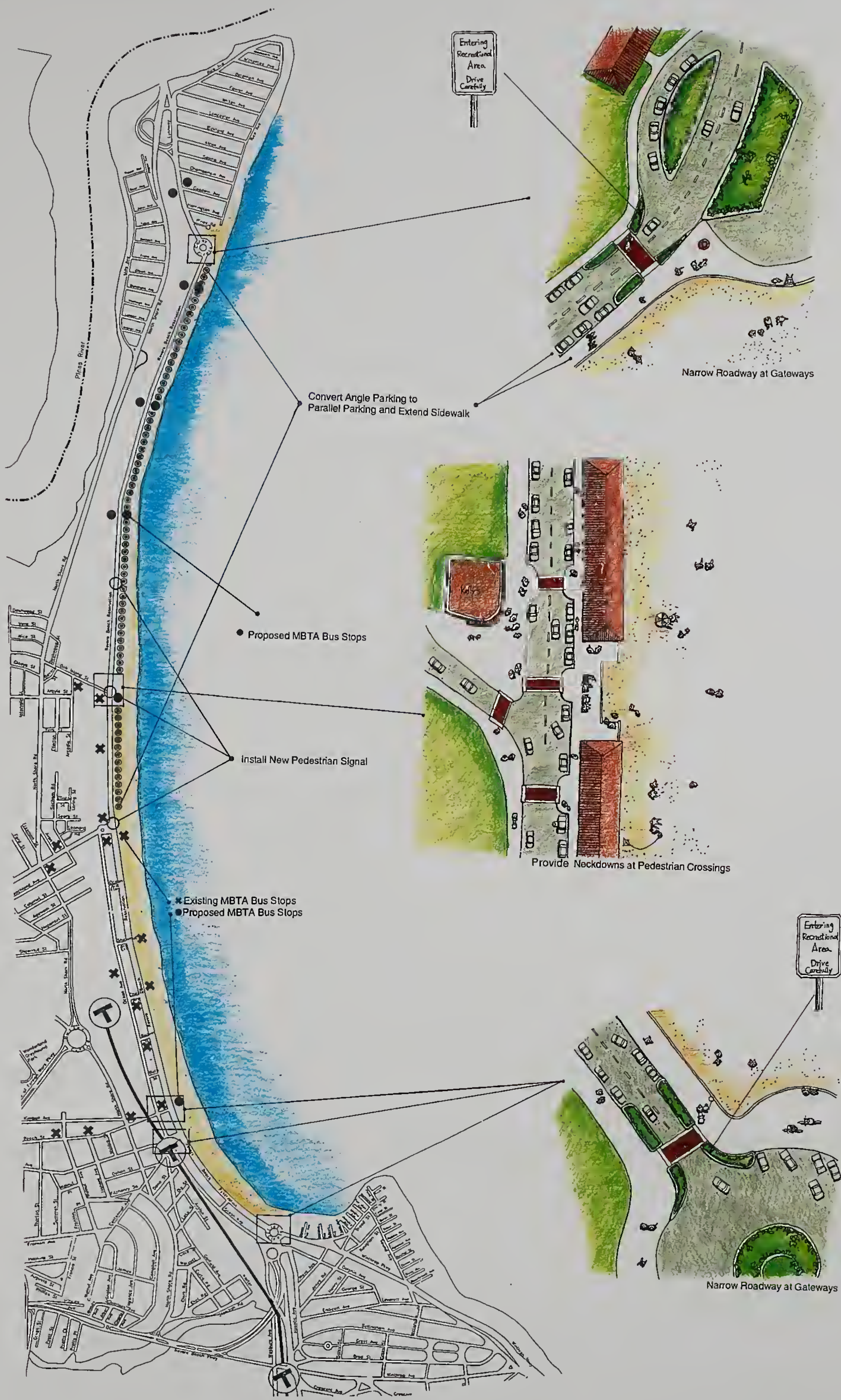


Figure 6-2
Recommended Improvements
Revere Beach Boulevard Traffic Management

- Separate eastbound and westbound phases on Saratoga Street (safety benefit)
- Upgrade signal equipment to current MUTCD standards

The recommended plan calls for removal of the traffic island on the westbound approach on Saratoga Street as well as reduction of that approach to two lanes–one left-turning lane and one shared lane for all the movements on the approach. The lane taken away from the approach is given to the eastbound departure for a total of two lanes.

On the eastbound approach on Saratoga Street, parallel parking on the left side of the roadway is eliminated. The roadway is restriped to allow two lanes. The left lane is a through-left shared lane and the right lane is a through-right shared lane. The added capacity on the eastbound approach and departure is needed for the PM eastbound traffic volume.

The improvements to the northbound and southbound approaches on Bennington Street require the removal of parking on each approach and departure for a minimum of 600 feet from the intersection. The removal allows the addition of an exclusive left-turn lane for both directions and an exclusive right-turn lane for the northbound direction. The addition of the exclusive left-turn lanes permits storage for turning vehicles and prevents them from impeding through movements. It also allows two through lanes for each direction, which would adequately handle the traffic volumes during each peak. The exclusive right-turn lane is needed to serve the 500+ vehicles turning onto Saratoga Street during the PM peak hour.

2) Main Street at Tileston/Oakes Street, Everett

Signal retiming is recommended, along with upgrading of the equipment.

- Upgrade signal equipment to current standards
- Change exclusive pedestrian phase to concurrent pedestrian phase
- Shift time from pedestrian phase to Main Street

It is suggested that the exclusive "all-walk" pedestrian phase be eliminated and that pedestrians cross concurrently with parallel vehicular traffic. The green time of the exclusive pedestrian phase can then be shifted to Main Street approaches to reduce intersection congestion. A warning sign should be installed on all right-turning approaches to remind motorists to yield to crossing pedestrians.

3) Bennington Street/State Road at Winthrop Avenue, Revere

Signal timing adjustments and lane restripings are recommended.

- Restripe eastbound Winthrop Avenue to add an exclusive right-turn lane
- Restripe the left lane on northbound Bennington Street as an exclusive left-turn lane
- Separate the northbound and southbound phases (safety benefits)
- Install "No Turn on Red" signs on each corner (pedestrian safety benefits)

To ensure that the new right-turn lane on Winthrop Avenue is kept clear, better enforcement of the parking prohibition by the Revere police would be needed, as there frequently are illegally parked vehicles in this area. Better signage indicating the parking prohibition is also recommended.

4) Route 16 at Winthrop Avenue/Harris Street, Revere

Signal retiming is recommended.

- Reduce cycle length from 158 to 90 seconds
- Reallocate green time from Route 16 to northbound Winthrop Avenue

5) Route 1A at Revere Street, Revere

Signal retiming is recommended. There are currently both exclusive left-turn phases and leading green phases. It is suggested that the exclusive left-turn phases be removed, with the leading green eastbound on Revere Street beingretained for all time periods, along with a leading green southbound in the AM peak period and northbound in the PM peak period on Route 1A.

Safety concerns were raised about the removal of exclusive left-turn phases. Based on the volumes collected on June 11, 1997, calculations indicate that the left turns on Route 1A and Revere Street can be made safely under permitted rather than protected green operation. If this retiming plan is implemented, operations should be monitored to ensure that these left turns are indeed made safely.

6) Route 1A at Beach Street, Revere

Signal retiming is recommended.

- Reduce cycle length to 60 seconds
- Allocate some of Route 1A green time to Beach Street
- Reduce existing yellow/red time of 6 seconds to 4 seconds for all phases

Observations at this intersection indicated that traffic on southbound Route 1A frequently backs up from Mahoney Circle during the AM peak period. Presumably this condition will not occur as frequently once the Mahoney Circle project is completed.

7) Route 60 at Revere Street, Revere

Volumes are well above the lane capacities on most approaches of this intersection. Signal timing adjustments cannot solve the existing problems here. Upon completion of the Mahoney Circle project, assuming it can reduce the number of Route 60 southbound left turns by half, the signal can be retimed to operate efficiently during the AM peak and at capacity during the PM peak. Improvements at Mahoney Circle must be designed, in part, to draw these left turns away from this intersection and improve access to Wonderland parking areas from the north and west. In addition, extension of the Blue Line or construction of some version of the Wonderland Connector would be expected to draw some trips away from Wonderland, also reducing traffic along Revere Street. Since no short-term solutions are available, congestion relief at Route 60 and Revere Street is tied to long-range improvements at Mahoney Circle and to North Shore transit.

6.1.4 Revere Beach Parkway (Route 16) Signal Coordination

Signal coordination is recommended for the following intersections of Revere Beach Parkway:

- Lewis Street
- Second Street
- Spring Street

- South Ferry Street
- Vine Street
- Vale Street (traffic signal proposed by a new Stop & Shop development on the parkway)
- Everett Avenue
- Washington Street
- Garfield/Webster Street

A preliminary traffic signal analysis does show that it is possible to provide improved service on Revere Beach Parkway with signal coordination. However, adjusting the traffic signals will negatively affect some cross streets unless changes are made to their approaches as well. Most cross streets that need improvement only require the addition of a separate left-turn lane.

The following cross streets require no additional work with Revere Beach Parkway signal coordination:

- Lewis Street
- Spring Street
- South Ferry Street
- Vine Street
- Vale Street

The following streets require separate left-turn lanes at their intersection with Revere Beach Parkway in order to operate properly with Revere Beach Parkway signal coordination:

- Everett Street
- Washington Street
- Garfield/Webster Street

The intersection of Revere Beach Parkway at Second Street requires major reconstruction in order to provide acceptable traffic signal operations, due to the high traffic volumes. Providing left-turn lanes on Second Street and a right-turn lane on Revere Beach Parkway eastbound would result in a good level of service.

6.1.5 Pedestrian Safety Improvements

Pedestrian safety improvements are recommended for three intersections in the study area. The intersections were selected based on Registry of Motor Vehicle accident records and suggestions from public meetings.

1) Bennington Street at Saratoga Street, East Boston

In addition to the traffic operation improvements presented in section 6.1.3, pedestrian safety improvements are recommended for this intersection. It is recommended that the exclusive pedestrian phase be extended from 25 seconds to 28 seconds. The new phase length is based on a crossing distance of 125 feet (the distance across the northbound Bennington Street leg) and a crossing speed of 4.5 feet per second. A 1-second all red is suggested at the end of the pedestrian phase to allow extra time for pedestrians to clear the intersection.

Many pedestrians have a misconception about "Walk/Don't Walk" pedestrian indicators, believing they should be able to get all the way across the street during the "Walk" indication (before the "Don't walk" indication begins). A sign explaining pedestrian indications at signalized intersections may be warranted at this intersection.

- Lengthen pedestrian phase
- Extend southwest corner of intersection to shorten pedestrian crossing distance
- Improve pedestrian understanding of "Walk/Don't Walk" indicators
- Provide more enforcement of prohibition of right turns on red and of exclusive pedestrian phase

All of these pedestrian improvements are recommended regardless of whether the traffic operations improvements are made.

2) Revere Beach Boulevard at Oak Island Street, Revere

The recommended pedestrian improvements for this location listed below are included in the Revere Beach Boulevard Traffic Management recommendations. However, they can be implemented as an individual project.

- Provide pedestrian staging areas (a.k.a. "neckdowns") at pedestrian crossing areas; make crosswalks more prominent; install "Cross Only at Crosswalk" signs
  - Helps motorists and pedestrians see one another better
  - Encourages pedestrians to cross at appropriate locations
  - Shortens pedestrian crossing distances
- Install new pedestrian signal for pedestrians to cross Revere Beach Boulevard

3) Broadway (Route 107) at Central Avenue, Revere

Traffic problems were not noted at this intersection, but this location was a source of pedestrian complaints at the public meetings. The following recommendations address the concerns expressed.

- Repair existing concurrent pedestrian phase
- Install full traffic signal operation
- Install pedestrian buttons and add an exclusive pedestrian phase as part of that installation
- Restripe crosswalks
- Provide a wheelchair ramp on the southeast corner

This intersection is part of a closed-loop signal upgrade to be implemented at seven locations along Route 107 from Fenno Street to Revere Street. At the very least, the existing concurrent pedestrian phase will be repaired in the course of that project. Due to the high number of reported accidents at this location, however, it is recommended that an exclusive pedestrian phase be installed. This will allow pedestrians to cross the intersection without the interference of turning vehicles.

6.2 Long-Range Improvements

The long-range improvements are more costly and would take longer to build than the short-range improvements. The main points of the recommended alternative for each location are summarized below. All the alternatives that were considered meet minimum feasibility considerations. Detailed descriptions of all of the alternatives are presented in chapter 4.

6.2.1 Route 1/ Route 16 Interchange

Currently, there is no direct connection from Route 16 westbound to Route 1 northbound or from Route 1 southbound to Route 16 eastbound. Five alternatives that complete these connections were analyzed. Three (Alternatives 1, 2, and 2 Revised) involve at least one new signal on Route 16, while Alternatives 3 and 4 provide complete grade separation for all movements. The recommended improvement is Alternative 2 Revised, which combines signalized double left-turn lanes from Route 1 southbound with a standard on-ramp from Route 16 westbound to Route 1 northbound. This ramp would probably require taking the existing restaurant but no other structures (the exact right-of-way would be determined in the final design). Alternative 3 would preserve the restaurant, but its estimated cost of $7.3 million is considerably higher than the $3.9 million cost of the recommended alternative. Figure 6-3 shows the recommendation.

6.2.2 New Route 1A and Route 16 Connections

All the alternatives for this area except Alternative 1, which aims at only a slight improvement of existing conditions, were evaluated according to their ability to meet the following three objectives (listed in descending order of importance):

1. Improve connections between the tunnels and Logan Airport and Route 1, using Route 1A and Route 16 (to be successful, improving these also requires that improved connections at Routes 1 and 16 be constructed)
2. Provide a gateway to Revere Beach
3. Move Route 16 traffic away from Mahoney Circle

Three types of alternatives were examined, along with variations on each. Alternative 2, flyover ramps between Routes 1A and 16, provides a direct connection for two currently difficult moves, Route 1A northbound to Route 16 westbound and Route 16 eastbound to Route 1A southbound, thus meeting the first objective. However, this alternative does not provide a gateway to Revere Beach.

Alternative 3 provides a new direct connection between Routes 1 and 1A via Route 16, creates a gateway to Revere Beach by relocating Route 16 to the southeast, and should divert a significant amount of traffic away from Mahoney Circle. However, this design includes a new diamond (signalized) interchange, which may not be able to handle the heavy traffic volumes forecasted.

Alternative 4 is the recommended alternative. It is depicted in Figure 6-4 (which also shows the expected widening of Route 1A to six lanes, the grade separation at Boardman Street, and improved access to Suffolk Downs at the existing driveway site). Alternative 4 upgrades Alternative 3 by providing full grade separation for all of the important movements via a three-fourths cloverleaf design, and it accomplishes all three objectives. Although this is the most expensive alternative, requires the most land takings, and is the most visually imposing design, it is the only one which would accommodate a major redevelopment at Suffolk Downs plus other expected growth in the corridor. The alignment, as shown in Figure 6-4, would miss most of the proposed developments in the area, and could be moved in response to environmental and economic development concerns.

The "green" aspects of both Alternatives 3 and 4, including new parks with pedestrian/bicycle paths and waterfront access, are important components of these designs, and it is the recommendation of this study that they be included in any final design.

6.2.3 Route 1, North of Copeland Circle

As mentioned in chapter 2, poor geometrics, the absence of acceleration and deceleration lanes, low design speeds on Route 1, and the close spacing of ramps result in operational problems at the Route 1 interchange with Salem Street/Lynn Street in Malden. Three alternatives, ranging from safety improvements for the existing ramps to a complete redesign of Route 1 in the area, were considered.

Both minor and major improvements are recommended. To make immediate improvements to the safety of the interchange, Alternative 1 should be implemented. This would require the closing of three of the existing ramps, a slight redesign of the northbound on-ramp, minor changes on Salem Street, and designation of the existing climbing lane as a third travel lane. Figure 6-5 shows Alternative 1.

Long-term, particularly if Rowes Quarry is redeveloped, a more significant increase in capacity is called for. For accomplishing this, Alternative 3 is recommended. Alternative 3 provides for complete reconstruction of the Salem Street/Lynn Street and Route 99 interchanges and the addition of a third lane on Route 1 throughout the segment between Copeland Circle and the Route 99 interchange. Figure 6-6 shows this recommendation.

6.2.4 New Route 1A/Chelsea Street Bridge Connection

Lack of good access to Chelsea from Route 1A and Logan Airport, and the presence of regional trucks on local Chelsea streets, were two of the biggest concerns expressed by Chelsea in this study. The Chelsea Street Bridge Connector, which provides direct access to the new Chelsea Bridge, is designed to address both problems and is the recommended improvement (Figure 6-7). It not only would improve access to Chelsea and provide a direct path for trucks, but would also draw traffic away from Day Square in East Boston, which all Chelsea-bound traffic must currently use. In addition, this new connection could improve the flow of air freight traffic between Logan Airport and Chelsea.

6.2.5 Brown Circle

This rotary at the intersection of Route 107 and Route 60, Brown Circle, is the scene of frequent accidents and congestion. Two options for improving operations were analyzed: grade separation of Route 60 through traffic and conversion of the rotary to a signalized intersection. The signal alternative is recommended. Key points regarding this alternative include:

- Four to five lanes (including two left-turn lanes) are required on some approaches to effectively handle existing volumes
- Little or no right-of-way acquisition is necessary
- Improves the level of service for the overall intersection (to LOS D) and on most approaches (to LOS D or better)
- Should improve the accident rate of the intersection by reducing traffic conflicts

Figure 6-8 shows the alternative. It should be noted that this recommendation is based on the condition that the connections between Route 1 and Route 1A would have been improved and the future (2020) travel demand at this location would not exceed the present level. Otherwise, the grade separation or other options should be considered and further study of this location should be conducted.

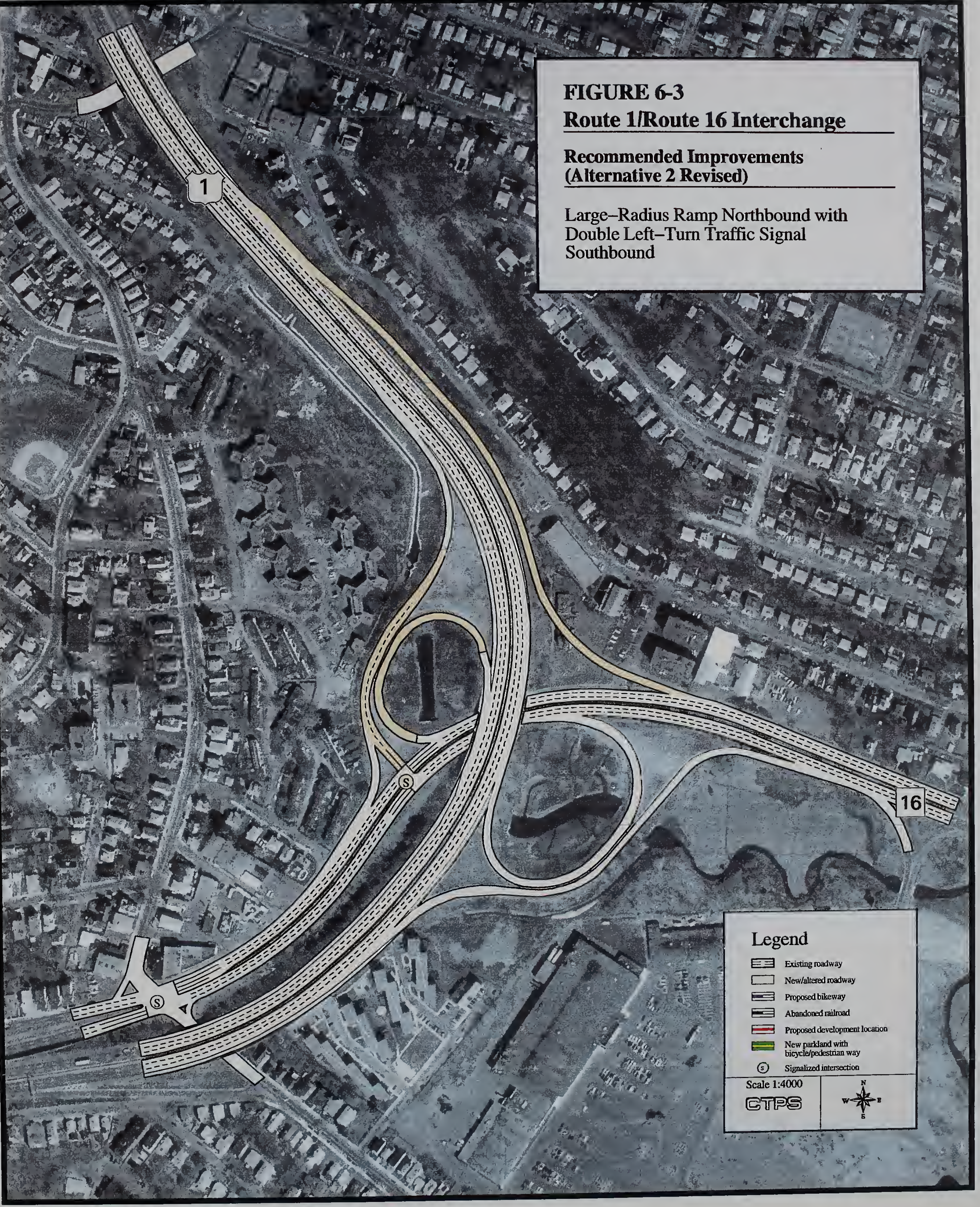


FIGURE 6-3
Route 1/Route 16 Interchange

Recommended Improvements (Alternative 2 Revised)

Large–Radius Ramp Northbound with Double Left–Turn Traffic Signal Southbound

FIGURE 6-4
Route 1A and Route 16 Connections
Recommended Improvements (Alternative 4)

3/4 Cloverleaf at Route 1A
with Route 16/Revere Beach Connector

Also shown:
Mahoney Circle Alternative 3
Suffolk Downs southwest entry grade separation
Six–Lane Route 1A

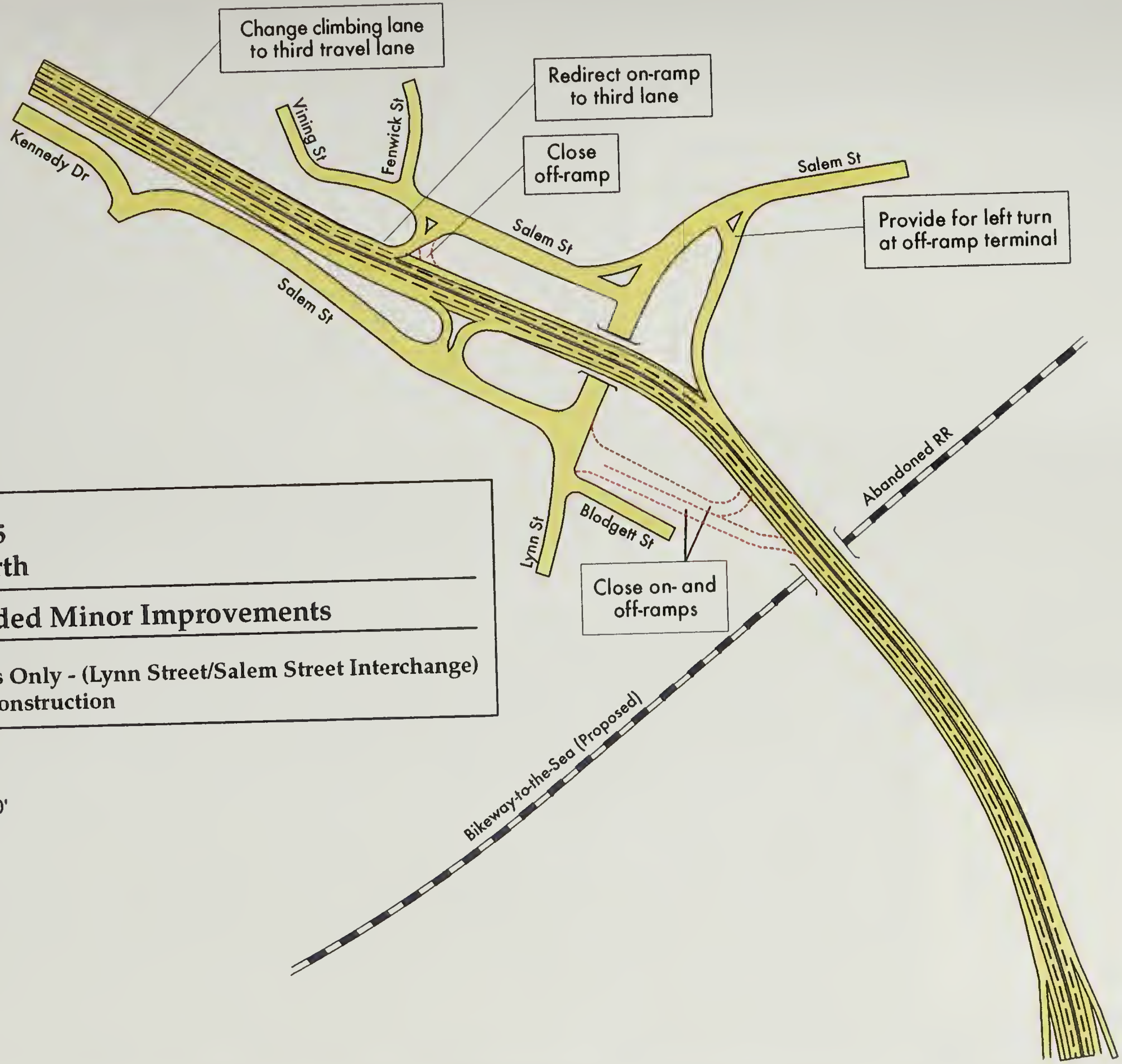


FIGURE 6–5
Route 1 North

Recommended Minor Improvements

Ramp Changes Only - (Lynn Street/Salem Street Interchange)
No Bridge Reconstruction

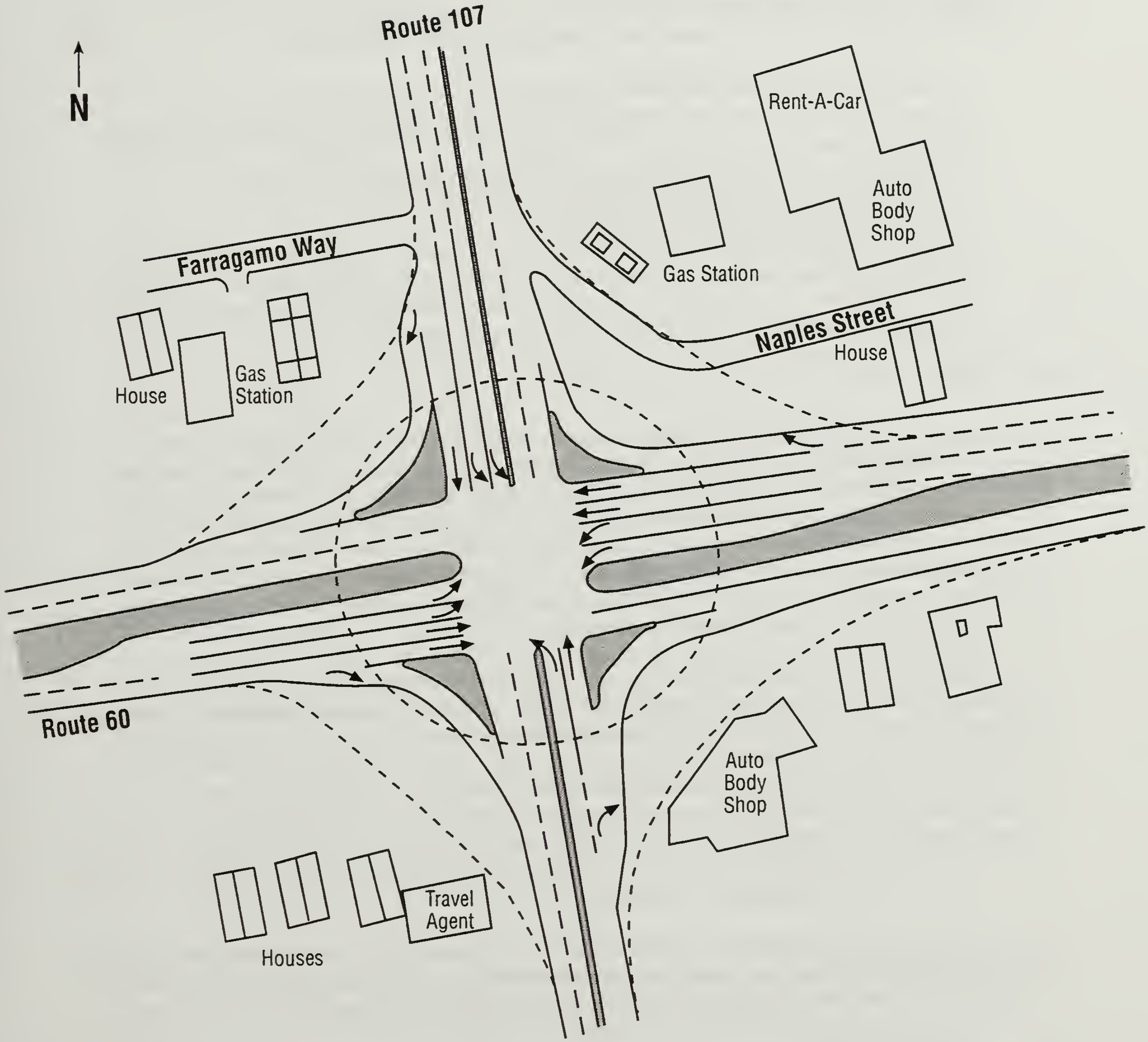
Scale: 1" = 350'

FIGURE 6-6
Route 1 North
Recommended Major Improvements (Alternative 3)
Route 1 Reconstruction:
Six–lane Route 1 roadway
between Copeland Circle and Route 99
New Lynn Street/Salem Street interchange
New northbound barrel at Route 99
Rowes Quarry
Revere
Copeland Circle
Legend
Existing roadway
New/altered roadway
Proposed bikeway
Abandoned railroad
Proposed development location
New parkland with bicycle/pedestrian way
Signalized intersection
Scale 1:7000
CTPS
N
W
E
S

FIGURE 6-7
Route 1A/Chelsea Street Bridge

Recommended Improvements

Figure 6-8
Recommended Improvements
Brown Circle Signalization



6.2.6 Route 60 Corridor between Brown Circle and Copeland Circle

Two options for improving operations along this corridor were reviewed. Alternative 1 would coordinate traffic signals in conjunction with the installation of new signals at Brown Circle. Alternative 2 would eliminate the signals providing access to Northgate Shopping Center and, in conjunction with reconstruction of Brown Circle to grade-separate Route 60, would allow unsignalized operation and limit curb cuts along Route 60 between Mahoney and Copeland circles.

Alternative 1 is the recommended alternative. It is recommended in conjunction with the signalization of Brown Circle. Key points regarding this alternative include:

- All existing turns would be allowed to occur
- Should reduce travel time and delays currently encountered between Brown Circle and Copeland Circle
- The intersection of Revere Street and Route 60 would still be problematic
- New signal equipment may be necessary
- The wide median in this area would allow additional left-turn bays and through lanes to be added, but an assessment of the need for these capacity increases should be made when improvements at Mahoney Circle have been made and the new connections at the Routes 1/16 and 1A/16 interchanges have been constructed.

6.2.7 Blue Line Extension

Part of the reason for the congestion at Mahoney Circle, and a major cause of the cut-through traffic on Revere Street, is vehicles heading for the parking lots serving Wonderland Station, the last stop on the Blue Line. Parking surveys done at Wonderland indicate that over half of all parked vehicles came from the north and accessed the site via the Route 1A bridge. Another third of the traffic may have used Revere Street to reach the lots. A Blue Line extension—besides providing better service to northern communities and opportunities for economic development, particularly in Lynn—would remove some of the traffic traveling through Revere and possibly free up some parking areas for future development.

Extending the Blue Line has been under study by the MBTA, and money was allocated in the most recent federal transportation legislation, TEA-21, for a large-scale study of this and other alternatives on the North Shore. It is the recommendation of this study's member communities that these studies be completed with an eye to eventually extending the Blue Line at least to Lynn, possibly as far as Beverly. The member communities also recommend that these studies not include any alternatives which would eliminate the Chelsea commuter rail stop or the Wonderland Blue Line station.

6.2.8 Water Transportation in the Area

The city of Revere is investigating rebuilding the historic pier at Revere Beach. Both Revere and Chelsea are looking at increased use of waterborne transportation modes. This study's member communities recommend that all forms of water transportation be encouraged.

6.3 Implementation

Implementation of the recommended improvements would require a collective effort from municipalities, operating agencies, and interested groups, and support from the general public. Many of the long-range improvements, as they would require significant resources and have a

regional impact, would need to be studied further prior to implementation. For example, the connections between Route 1 and Route 16 and between Route 16 and Route 1A would require further engineering design study, and the Blue Line extension would require a major investment study. The long-range recommendations are intended to be potential starting points for a process that will include developing additional alternatives, performing more detailed evaluations, and conducting a more rigorous public and environmental review process.

For implementation of the short-range highway improvements, such as intersection improvements, traffic signal coordination, pedestrian safety improvements, and traffic management measures, municipalities may request assistance from the Massachusetts Highway Department (MassHighway). The process for this, and the subsequent steps, are follows:[1]

1. The municipality must request, in writing, assistance from the MassHighway District 4 director. The letter should explain why improvements are needed, describe the proposed improvements, indicate the level of local support for the project, and convey a commitment that the project will be designed by the community and that any ROW acquisitions or easements required will be the responsibility of the municipality. A copy of the letter should be sent to the executive secretary of the Boston Metropolitan Planning Organization (MPO).
2. The district office will review the request and possibly ask for a Project Justification Report. It is the responsibility of the municipality to prepare the report, if requested, and submit it to the district office and the MPO.
3. At this point, the municipality should meet with the district office and MPO to discuss the potential priority of the proposed project and plan the remaining steps required to complete the process, possibly including holding an informational meeting to determine the degree of community support or opposition.
4. If the evaluation of the Project Justification Report (if any) is favorable and there is local support for the project, the district office will submit a favorable request to the Project Review Committee (PRC) of MassHighway. The PRC will then determine whether the proposed project is eligible for federal or state highway funding, and MassHighway will notify the municipality of the results.
5. Once the proposed project is approved, the municipality should request that the MPO place the project in the region's Transportation Improvement Program (TIP). The project must carry with it regional benefits and comply with the regional Transportation Plan.
6. Once the project is in the TIP, the municipality should prepare the necessary construction documents for submittal to MassHighway. Depending on the complexity of the project, submittals may be required at the 25%, 75%, or 100% design phase.
7. MassHighway advertises and awards the project, and issues a notice to proceed to start construction.

The recommendations for Revere Beach Boulevard traffic management and for Revere Beach Parkway signal coordination, though categorized as short-range improvements, have long-term regional significance. Their implementation requires support and assistance from the Metropolitan District Commission, the roadways' administrative agency.

Regarding implementation of short-range transit improvements: municipalities or any concerned individual may present proposals for service changes or new service to the MBTA's Service Planning group. All proposed changes are subject to a review and approval process that ensures that they are consistent with the guidelines of the MBTA's Service Delivery Policy and with the budget.

[1] The process described is for a short-range project that does not require an environmental impact assessment; none of this study's short-range improvements is expected to require one.